THE SCIENCE REPORTS OF THE RESEARCH INSTITUTES
TÔHOKU UNIVERSITY SERIES D (Agriculture)

THE REPORTS OF THE INSTITUTE FOR AGRICULTURAL RESEARCH

TÔHOKU UNIVERSITY

Vol. 5
1953

Published by
Tôhoku University, Sendai, Japan
(Rep. Inst. Agr. Res. Tôhoku Univ.)

COMMONWEALTH MYCOLOGICAL INSTITUTE
12 OCT 1954

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Response of Rice Plant Varieties on the Dressed Amount of Ammonium Sulphate Fertilizer*

Ichiro YAMANE

(Received Dec. 1, 1953)

I. Introduction

With regard to the great yield of rice plant varieties, it is essential to consider the relation between it and the amount of nitrogen fertilizer, because domestic agriculture customarily employs a great deal of such fertilizers. However, there are but few reports in corcern.

In Japan, especially in the northern part the amount of farmyard manure used is great. In this experiment the farmyard manure was not dressed, and there was no attempt to determine the optimum amount of ammonium sulphate for each variety. However, an attempt was made to clear the response of the rice varieties in the different levels of nitrogen fertilizer from the stand point of both yield and chemical analysis.

This experiment was performed in 1952 at the First Cultural Branch of the Tohoku Agricultural Experiment Station of the Ministry of Ag. & Forestry, which is at Hanadate village in Akita Prefecture. Writer is indebted to Mr. Tokunaga, chief of this branch, and his collaborators, especially to Miss Reiko Hosokawa for her assistance in various ways.

II. Experimental field

Hanadate village in Akita Prefecture is situated in lat. 39°27′58″ N., long. 140°28′26″ E., 24.8 m in average height above sea-level, and the yearly average temperature is 11.4°C, the amount of rainfall per year (including snow) is 1805 mm., the amount of fallen snow is 1 m., and the period under snow is 95 days.

This experiment station is in a small inland basin consisting of either alluvium or diluvium. There is only a single crop per year.

* The 106th report of the Institute for Agricultural Researdch, Tohoku University. (1953).

The profile of soil is as follows.

0–13 cm	cultivated layer, clay, brownish black colour.
13–23	somewhat hard layer, clay, brownish black.
23–45	hard layer, subsoil, clay, grayish black.

The general properties of the soil are given in Table 1.

Table 1. The properties of field soil (cultivated layer)

Mechanical analysis (by pipette method) (%)

mm 2–0.25	0.25–0.02	0.02–0.002	0.002 >
11.1%	11.7	76.1	4.6

Hot HCl soluble matter (by van Bemmelen & Hissink) (%)

SiO_2*	Al_2O_3	Fe_2O_3	MnO	CaO	MgO	P_2O_5
20.29%	8.21	6.36	0.10	0.63	1.73	0.26

* containing alkali soluble SiO_2

Other analysis

C	Humus	N	C/N	loss on ignition	drying effect	PH	Exchangeable Capacity
4.06%	7.98%	0.34%	11.9	19.1%	17.0*	5.2	26.0**

* NH_3-N mg/100 g Soil.

** m.e./100 g Soil.

The accumulation of black humus, the nitrogen content and soil drying effect+ are great.

As the soil is dried before the overflowing with water for cultivation of rice, the nitrogen supply from soil due to the drying effect is great. Since the natural supply of both phosphor and potassium are great, effects of the dressed phosphor and potassium fertilizer on the rice plant were not recognized.

Customarily the amounts of fertilizer are as follows: Farmyard manure 300 *Kan*++ per *Tan*, ammonium sulphate 6 *Kan* per *Tan*. superphosphate 6 *Kan* per *Tan* and potassium chloride 2 *Kan* per *Tan*. The average yield of brown rice are 2.5 *Koku* per *Tan* (100 *Kan* per *Tan*).

+ Drying effect of soil : When the paddy soil is dried and then overflown with water, some portion of the organic nitrogen in the soil is converted to NH_4-N and most of it is absorbed by the rice plant almost without loss. This problem has been studied by Dr. Shioiri at the Govermental Agricultural Experiment Station, Tokyo in 1937–1945.

++ *Kan* = 3.75 Kg. *Tan* = 300 *Tusbo* = 0.1 ha.
Koku = 180 litter (in brown rice ≒ 40 *Kan*)

III. Method of experiment

Plot : Dressed amount of ammonium sulphate (*Kan* per *Tan*) was distributed as follows.*

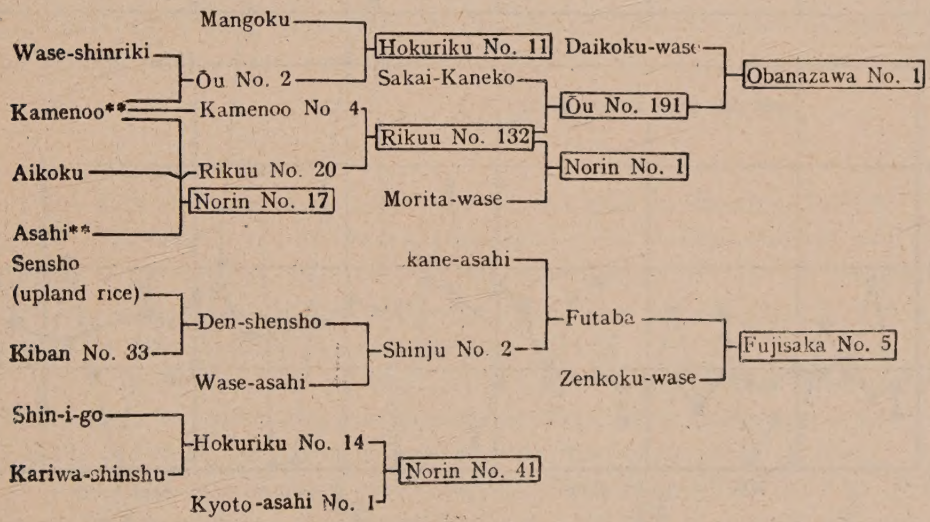
(1) Plot no (2) 6 *Kan* (3) 8 *Kan* (4) 10 *Kan* (5) 12 *Kan* (6) 14 *Kan* (7) 16 *Kan* (8) 18 *Kan* (9) 20 *Kan*.

One plot measured 20 *Tsubo* (20/300 *Tan*) and two replicates of 8 varieties were planted in each plot. The varieties used are shown in Table 2.

Table 2. Varieties used.

name	short name	plant type	maturing	resistance to blast disease
Fujisaka No. 5	F–5	heavy parnicle type	early maturing	strong
Norin No. 1	N–1	many 〃	early 〃	weak
Norin No. 17	N–17	heavy 〃	medium 〃	strong
Rikuu No. 132	R–132	intermediate type	medium 〃	intermediate
Obanazawa No. 1	Ob–1	heavy parnicle type	early 〃	〃
Norin No. 41	N–41	many 〃	medium 〃	〃
Hokuriku No. 11	H–11	heavy 〃	medium 〃	〃
Ōu No. 191	O–191	intermediate type	medium 〃	〃

All of the varieties were obtained by crossing at the Agricultural Experiment Station. Their relationship are as follows :



* Each plot was dressed by superphosphate 6 *Kan*, potassium chloride 2 *Kan* and no farmyard manure ; all (containing ammonium sulphate) base dressing.

** In north Japan, there are many varieties of Kameno-o's line and in central Japan that of Asahi line (containing Kyoto-asahi and wase-ashai).

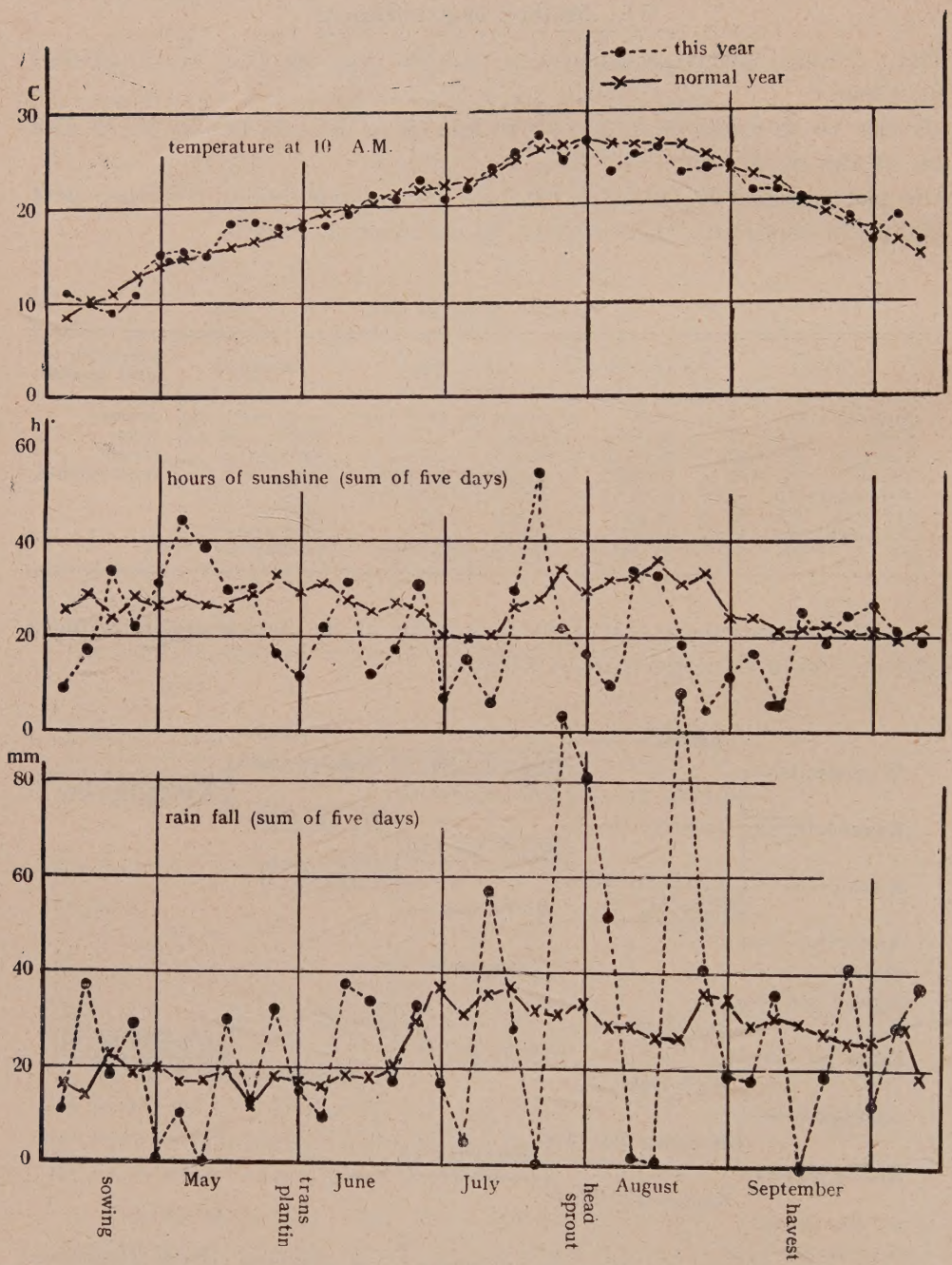


Fig. 1. Weather.

Date of cultivation

sowing and amount : 23 rd April ; 3 *Go* (540 ml) per *Tsubo*
plowing : at the beginning of May.
transplanting : 4 th June, 64 stumps per *Tsubo*, each containing 3 plants
harvest : 18 th September N–1, F–5, Ob–1
24 th " other varieties
weeding : 3 times.

IV. Climate

The climate of this year and of normal years are as shown in Fig. 1. This station, which is situated in the north, has a cool and humid climate, and the average temperature at 10 A. M. throughout the year is 11.4°C. It begins to snow in November and the snow covered becomes permanent from the beginning of December to March of the next year. But during the last half of the planting period, rice plants are favoured with fair weather, and the water temperature occasionally reaches as high as 40 °C. However, during years when fair weather is rare and the temperature low, the condition is called "the cool damage" and the harvest is little. This condition was serious in 1934 and 1941.

In 1952 when this experiment was performed, the rice plant was favored with fair weather. Because of the low temperature during the seedling period, the sprout was somewhat bad, but this condition was followed with fair weather. From late July to early August, the weather was not good but, generally speaking, the weather of this year was normal.

V. Results

1. Measurement of growth

The data of measurement only in the harvest time are shown in Table 3 :

(i) The heights and numbers of parnicle of every variety increased with the increase of the nitrogen fertilizer. In the measurement of July lst, the differences of height by the level of dressed nitrogen were few (N_{20}/N_0 1.2), but the number of tillers differed considerably (N_{20}/N_0 1.5).

(ii) The length of the parnicle (of the longest tiller) was not influenced by the difference in the amount of additional fertilizer, being mostly 15 percent. In 0–191 and H–11 the rate of increase exceeded that of the other varieties.

(iii) The length of straw (of the highest tiller) increased as much as 20–30 percent by the addition of nitrogen fertilizer. The rate of increase was nearly equal in all varieties, except N–1.

(iv) Numbers of parnicle : the rate of increase by the nitrogen fertilizer was very large, in some varieties N_{20}/N_0 reached near 2, in Ob–1,R-132 and F–5 they small but in N–1, N–17, N–41, H–11 and O–191 were large.

Table 3. Growth (ratio) of harvested plants.

		numbers of parnicle	length of parnicle	length of straw			numbers of parnicle	length of parnicle	length of straw
F—5	0	100	100	100	Ob—1	0	100	100	100
		(10.5)	(18.2cm)	(65.8cm)			(10.9)	(19.7cm)	(83.2cm)
	6	116	100	106		6	110	97	109
	8	109	100	109		8	105	96	109
	10	115	100	111		10	124	96	111
	12	141	103	108		12	123	99	114
	14	143	95	118		14	138	94	118
	16	167	107	125		16	158	97	124
	18	166	101	125		18	146	101	121
	20	160	106	129		20	145	103	126
N—1	0	100	100	100	N—41	0	100	100	100
		(13.0)	(16.6)	(64.8)			(14.0)	(16.1)	(67.5)
	6	137	100	112		6	113	101	104
	8	125	102	113		8	112	99	109
	10	136	100	110		10	149	104	122
	12	140	102	121		12	136	99	115
	14	148	102	122		14	136	104	121
	16	181	100	134		16	176	109	131
	18	197	102	128		18	172	105	123
	20	172	105	134		20	182	104	125
N—17	0	100	100	100	H—11	0	100	100	100
		(10.5)	(18.4)	(76.3)			(9.4)	(18.2)	(77.2)
	6	125	96	104		6	114	105	105
	8	124	98	110		8	136	105	111
	10	136	97	113		10	145	107	113
	12	155	98	114		12	151	104	114
	14	159	95	114		14	156	108	116
	16	167	99	120		16	176	108	122
	18	202	103	118		18	177	111	117
	20	198	103	125		20	178	113	121
R—132	0	100	100	100	O—191	0	100	100	100
		(11.3)	(17.9)	(83.8)			(10.8)	(18.0)	(74.6)
	6	136	98	110		6	137	107	108
	8	123	97	109		8	137	104	113
	10	140	95	110		10	143	103	117
	12	157	96	116		12	154	107	117
	14	144	102	116		14	170	112	123
	16	163	104	118		16	164	112	125
	18	165	105	119		18	162	110	121
	20	157	110	127		20	171	114	124

On the other hand, it is said that N–1 and N–41 belong to the many-parnicle type, F–5, H–11, Ob–1 and N–17 to the heavy-parnicle type and the others to the intermediate type. In the range of this investigation there seemed to be no relation between the amount of nitrogen fertilizer and plant type.

(v) The blast disease broke out in the plots dressed with more than 16 *Kan* per *Tan*; N–41, 0–191, R–132 and Ob–1 were most strongly attacked with the blast disease but their investigation could not be completed.

(vi) The stem falling was caused in the plots dressed with more than 16 *Kan*, but F–5, N–1 and N–41 showed no such phenomenon.

(vii) Head sprout

The head sprout was inclined to delay in every variety due to the increase of

nitrogen fertilizer.

The early maturing varieties as F–5, N–1 and Ob–1 sprouted on August lst. The dates of the head sprout in F–5, were equal in plots dressed with from O to 16 *Kan* and the plots dressed with 18 and 20 *Kan* were delayed 2 days. In N–1 and Ob–1, the difference between the plots dressed with O *Kan* and 20 *Kan* was 4 days.

The dates of the head sprout in N–41 and R–132 were near August 4th, and in others between 6–8th August in the low nitrogen level. In the medium maturing varieties the difference among the various dressed plots was a week.

2. Yield measurement

The yield measurement was performed according to the yield estimation

Table 4. Yields (*Kan* per *Tan*) (air dry)

		straw	grain	brown rice	grain/straw			straw	grain	brown rice	grain/straw
F–5	0	91	81	66	0.89	Ob–1	0	105	99	79	0.89
	6	118	107	87	0.91		6	126	115	90	0.91
	8	122	104	86	0.85		8	119	115	89	0.96
	10	120	107	88	0.89		10	137	122	96	0.89
	12	136	124	100	0.91		12	149	130	99	0.87
	14	143	130	107	0.92		14	151	123	94	0.82
	16	144	136	110	0.94		16	158	125	95	0.79
	18	147	141	113	0.96		18	154	117	86	0.78
	20	157	141	113	0.90		20	156	105	77	0.70
N–1	0	88	64	52	0.73	N–41	0	116	97	81	0.84
	6	141	91	73	0.65		6	132	112	95	0.85
	8	138	99	79	0.71		8	134	114	96	0.85
	10	135	95	77	0.70		10	181	146	122	0.81
	12	152	105	86	0.69		12	153	126	106	0.83
	14	150	117	94	0.78		14	154	128	107	0.83
	16	149	110	89	0.74		16	184	109	91	0.60
	18	165	124	95	0.75		18	168	101	80	0.60
	20	172	125	97	0.72		20	174	110	93	0.63
N–17	0	107	97	80	0.90	H–11	0	79	100	82	1.25
	6	125	109	90	0.88		6	116	122	99	1.05
	8	137	116	95	0.85		8	125	131	105	1.05
	10	158	132	108	0.84		10	143	128	104	0.89
	12	145	127	104	0.87		12	149	128	102	0.86
	14	148	138	112	0.93		14	135	122	97	0.90
	16	161	128	102	0.79		16	151	121	96	0.80
	18	164	124	100	0.76		18	160	112	88	0.70
	20	158	136	104	0.81		20	157	96	76	0.61
R–132	0	102	97	81	0.95	O–191	0	87	97	90	1.12
	6	141	122	101	0.87		6	121	122	98	1.01
	8	142	121	100	0.85		8	132	130	104	0.99
	10	155	119	99	0.77		10	142	126	101	0.89
	12	153	122	100	0.80		12	141	124	102	0.88
	14	148	110	89	0.74		14	155	115	91	0.74
	16	169	110	90	0.65		16	144	91	71	0.63
	18	166	117	95	0.71		18	158	80	61	0.51
	20	161	104	88	0.65		20	154	86	66	0.56

method per *Tsubo* as employed by this station. When the differences of 2 plots having had the same treatment were large in some plots (refer to Fig. 2), great care is required in judgement. The results obtained are shown in Table 4 and Figs. 2. Briefly their accounts are as follows :

(i) Weight of straw. The increase of straw weight due to the increase of the nitrogen fertilizer was different among varieties. H-11 and N-1 were strongly increased ($N_{20}/N_0=2$), Ob–1 and N-17 slightly and the other varieties were intermediate in weight.

(ii) Weight of grain

(a) In the grain weight the varieties were classed into two groups. The first : the increase of yield was parallel to the increase of fertilizer. F–5, N–1 and N–17 belong to this group. The second : In the high level of nitrogen fertilizer the yields decreased. Other varieties belong to this group.

(b) In the first group, F–5 was the greatest in both increase rate and maximum yield. In N–1, the grain yields were somewhat small.

(c) In the second group, the yield of 0–191 and H–11 decreased most vigorously by increasing the fertilizer and the maximum yields were at the low dressed plot.

N–41 and Ob–1 belong to the varieties whose maximum yield was at the somewhat much dressed plot. R–132 was like N–41 and Ob–1, but the differences of yield by dressing were small.

(d) In the case of less fertilization (0–8 *Kan* per *Tan*), F–5 and N–1 gave the least yield among varieties and R–132, O–191 and H–11 had the maximum yield. In the greatest dressing, the yields of O–191 and H–11 were least among varieties.

(iii) Grain-straw-ratio :

(a) In general, this ratio decreased with the increase of the dressed amount, but that of F–5 and N–1 were almost equal or rather increased.

(b) On the contrary, the ratio of H–11 and O–191 was more than 1 in the range of 0–8 *Kan* but decreased vigorously with the increase of dressed amount.

(c) The other varieties were intermediate between two classes.

(iv) Without concerning the chemical analysis, the writer grouped the varieties as follows :

lst group : The yield increased to the last stage with increase of the dressed amount of nitrogen fertilizer, F–5, N–1 and N–17

2nd group : Intermediate group, R–132, Ob–1 and N–41

3rd group : The grain yields at the low nitrogen level were great but it decreased vigourously with the increase of the dressed amount, H–11 and O–191.

3. Analysis of nitrogen

(i) Nitrogen content

The results obtained are given in Table 5. The accounts are summarized as follows :

Table 5. N% (oven dry)

		F-5	N 1	N-17	R-132	Ob 1	N 41	H-11	O-191
straw	0	0.53	0.45	0.53	0.52	0.53	0.54	0.48	0.47
	6	0.54	0.54	0.62	0.61	0.57	0.59	0.56	0.51
	8	0.61	0.63	0.64	0.58	0.54	0.61	0.60	0.53
	10	0.69	0.61	0 65	0.62	0.58	0.74	0.62	0.53
	12	0.67	0.63	0.77	0.64	0.65	0.70	0.62	0.66
	14	0.74	0.64	0.65	0.74	0.70	0.74	0.73	0.67
	16	0.76	0 68	0.68	0.70	0.70	0.89	0.90	0.79
	18	0.77	0.75	0.83	0.71	0.71	0.87	0.83	0.79
	20	0.80	0.87	0.79	0.78	0.69	0.78	0.84	0 80
grain	0	0.98	1.13	1.01	1.00	1.01	0.96	0.93	0.88
	6	1.03	1.16	1,01	1.09	1.07	0.98	0.97	0.99
	8	1.01	1.10	1.03	1.06	1.12	1.01	1.02	1.04
	10	1.02	1.15	1 13	1.08	1 04	1.10	1.05	1.05
	12	1.07	1.15	1.10	1.17	1.17	1.04	1.06	1.17
	14	1.11	1.22	1.12	1.30	1.25	1.12	1.22	1.21
	16	1.05	1.18	1.12	1.21	1.18	1.14	1.27	1.21
	18	1.16	1.27	1.22	1.22	1.24	1 16	1.22	1.25
	20	1.21	1.33	1.22	1.38	1.28	1.16	1.16	1.17

(a) Nitrogen contents increased with the increase of the fertilizer, and amounted to 0.9–1.4 percent in the grain and 0.45–0.9 percent in the straw.

(b) In F–5 and N–1 the nitrogen contents of the grain were almost unchanged at the low level (O–12 *Kan*), but in N–1 it was higher than others at the low nitrogen level.

(c) In O–191 and H–11 the nitrogen contents of the grain were increased vigorously with the fertilizer from a low level, but that exceeding 16 *Kan* dressed decreased. It seemed that this was caused by the sampling error or by the hinderance of ripening caused by the disease or falling down.

(d) Nitrogen contents of straw increased with the increase of the dressing amount. It seems better to ascribe the error to sampling in the case of N–41 and N–17, which inclined to decrease at the high level of nitrogen fertilizer.

(ii) Nitrogen yield per *Tan* (Table 6)

Nitrogen absorbed by the rice plant per *Tan* are calculated as shown in Table 6 :

(a) Nitrogen yields were inclined to increase with the increase of the dressing amount, but in H–11, O–191 and Ob–1 it showed the decrease at the high nitrogen level. This may be due to the little nitrogen yield of the grain in the first two and to the little nitrogen yield of straw in Ob–1.

(iii) Grain-straw ratio of nitrogen yield (Table 6)

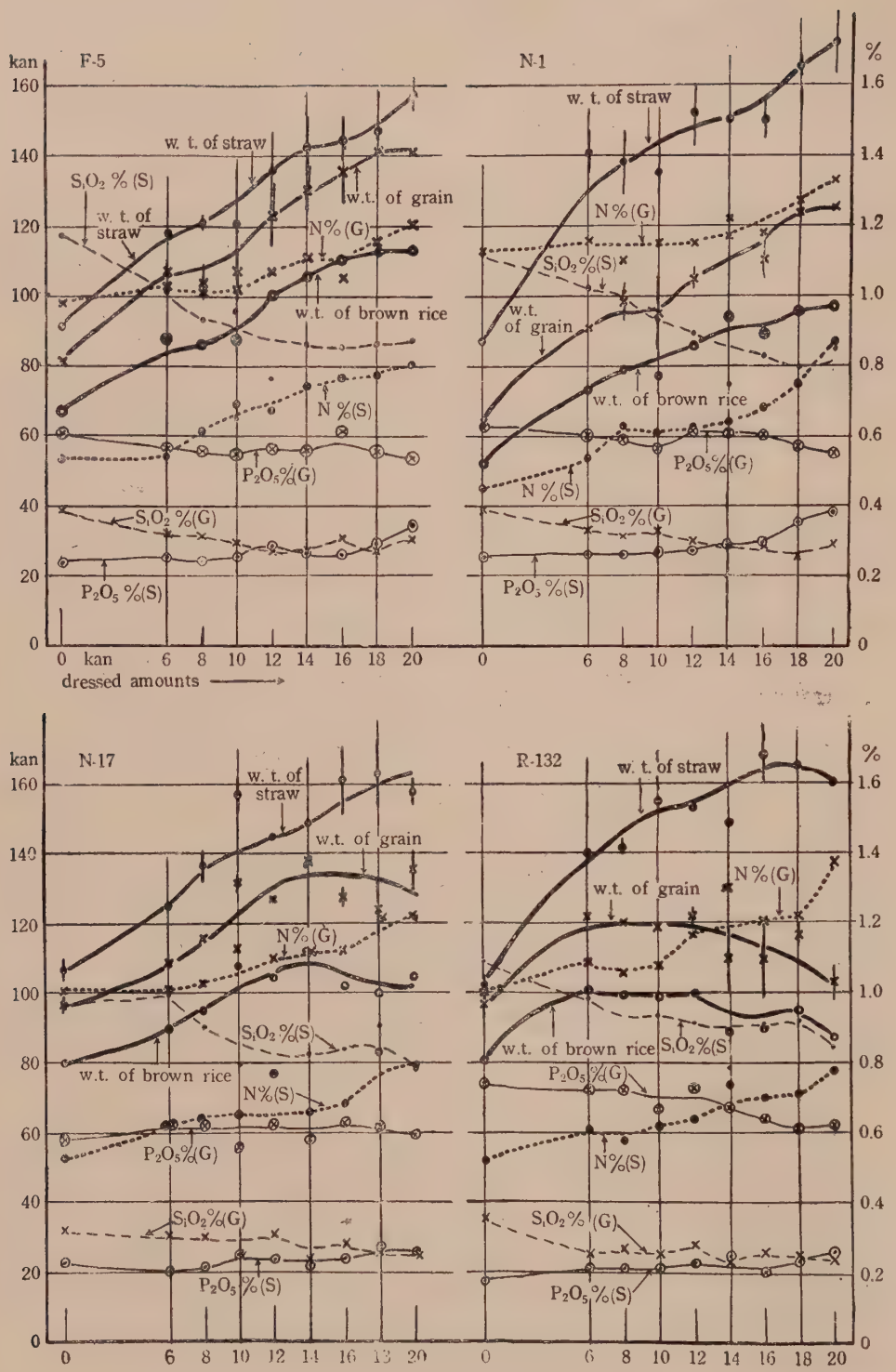


Fig. 2. (1) Yields and analytical data.

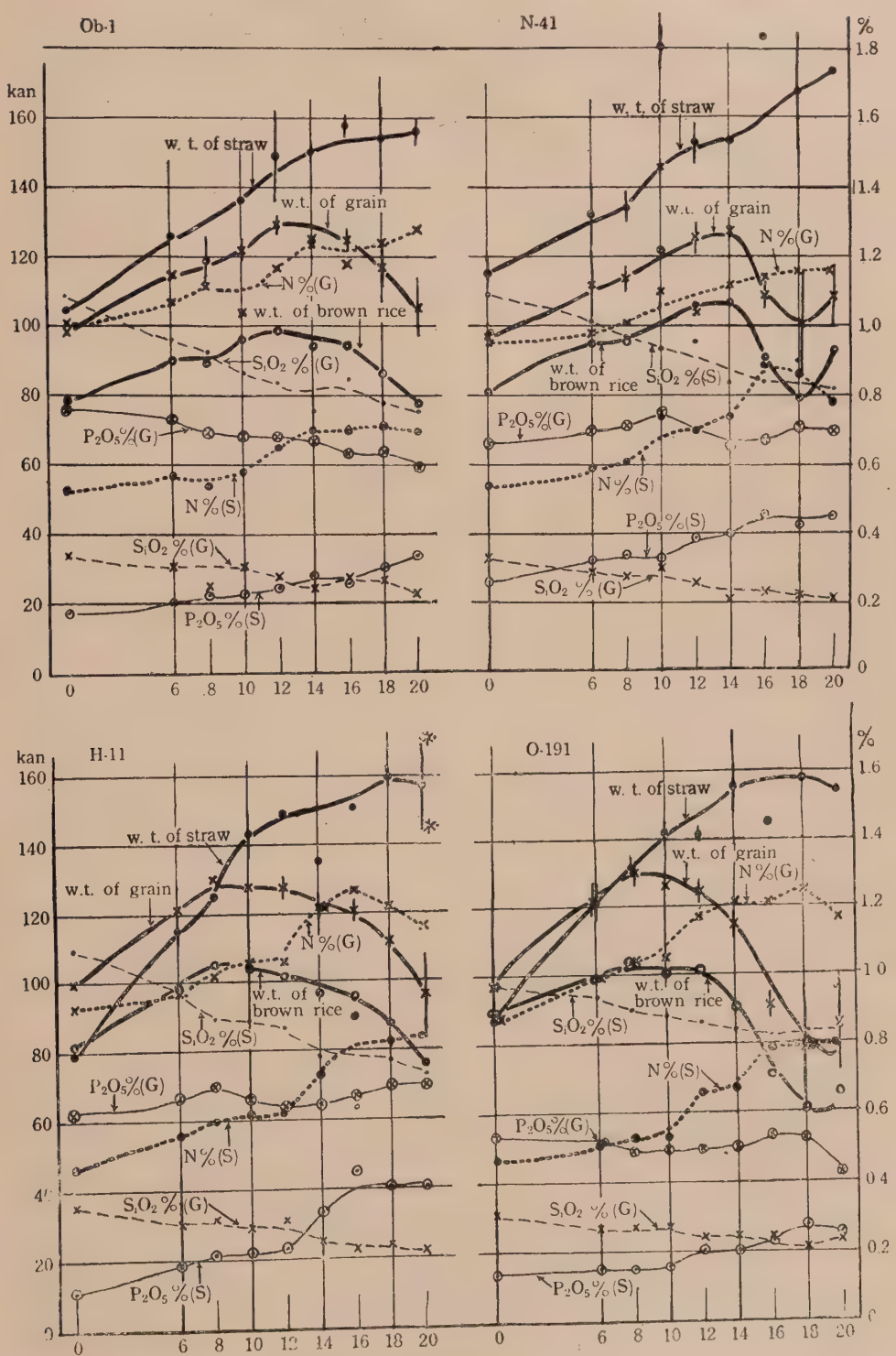


Fig. 2. (2).

* upper end is large one and lower end is small one of two replicates.
SiO_2% = per cent indicated ×10. S : Straw. G : Grain.

Table 6. Nitrogen amounts in plants (*Kan* per *Tan*)

		straw	grain	sum	grain/straw		straw	grain	sum	grain/straw
F—5	0	0.40	0.59	0.99	1.47	Ob—1	0.43	0.67	1.10	1.61
	6	0.53	0.80	1.33	1.50		0.59	0.87	1.46	1.49
	8	0.58	0.76	1.32	1.32		0.53	0.93	1.46	1.75
	10	0.70	0.80	1.50	1.14		0.63	0.90	1.54	1.42
	12	0.64	0.97	1.61	1.51		0.70	1.07	1.77	1.52
	14	0.83	1.03	1.87	1.24		0.85	1.10	1.95	1.30
	16	0.89	1.04	1.93	1.18		0.96	1.03	1.89	1.21
	18	0.88	1.22	2.10	1.39		0.85	1.04	1.89	1.23
	20	1.09	1.23	2.32	1.13		0.80	0.94	1.73	1.18
N—1	0	0.28	0.51	0.79	1.82	N—41	0.45	0.65	1.10	1.46
	6	0.58	0.73	1.30	1.27		0.55	0.76	1.31	1.39
	8	0.70	0.77	1.47	1.11		0.67	0.80	1.46	1.20
	10	0.65	0.76	1.42	1.17		0.95	1.11	2.05	1.17
	12	0.73	0.83	1.56	1.14		0.72	0.90	1.63	1.25
	14	0.71	0.99	1.71	1.39		0.92	0.97	1.89	1.06
	16	0.81	0.90	1.71	1.11		1.14	0.85	1.98	0.75
	18	0.99	1.07	2.06	1.09		1.20	0.80	1.99	0.67
	20	1.21	1.14	2.35	0.94		1.14	0.90	2.03	0.65
N—17	0	0.45	0.69	1.14	1.50	H—11	0.32	0.67	0.99	2.06
	6	0.57	0.79	1.36	1.38		0.59	0.81	1.40	1.37
	8	0.68	0.84	1.52	1.23		0.63	0.92	1.55	1.45
	10	0.77	1.04	1.82	1.35		0.69	0.92	1.61	1.23
	12	0.84	0.96	1.80	1.15		0.72	0.93	1.64	1.29
	14	0.98	1.01	1.99	1.05		0.72	1.02	1.74	1.41
	16	0.96	1.02	1.89	1.19		1.00	1.06	2.05	1.06
	18	1.03	1.05	2.07	1.02		1.01	0.99	2.00	0.97
	20	1.09	1.16	2.25	1.06		0.99	0.80	1.80	0.81
R—132	0	0.47	0.71	1.17	1.51	O—191	0.34	0.62	0.96	1.83
	6	0.63	0.96	1.59	1.52		0.43	0.85	1.29	1.97
	8	0.62	0.91	1.53	1.48		0.56	0.92	1.48	1.66
	10	0.71	0.93	1.64	1.31		0.54	0.95	1.48	1.77
	12	0.73	1.04	1.77	1.42		0.73	1.04	1.77	1.44
	14	0.84	1.03	1.87	1.23		0.97	1.01	1.87	1.16
	16	0.80	0.97	1.77	1.21		0.95	0.79	1.74	0.84
	18	0.82	1.00	1.81	1.23		0.98	0.72	1.70	0.73
	20	0.95	0.98	1.92	1.03		1.17	0.71	1.88	0.61

(a) This ratio was always higher than 1 and high at the low nitrogen level, but decreased with the increase of the dressed amounts of fertilizer.

(b) It is noticeable that in H–11 and O–191 this ratio was especially high at the low nitrogen level but became very low at the high level.

Table 7. Amounts absorbed by plants in order to produce 40 *Kan* brown rice. (*Kan*)

	F–5	N–1	N–17	R–132	Ob–1	N–41	H–11	O–191
0	0.61	0.61	0.57	0.58	0.56	0.54	0.48	0.43
6	0.61	0.72	0.60	0.63	0.64	0.55	0.57	0.53
8	0.63	0.75	0.64	0.61	0.65	0.62	0.59	0.57
10	0.68	0.73	0.67	0.66	0.64	0.67	0.62	0.59
12	0.64	0.73	0.69	0.71	0.72	0.62	0.65	0.70
14	0.70	0.72	0.70	0.84	0.83	0.71	0.71	0.82
16	0.70	0.77	0.74	0.79	0.80	0.86	0.86	0.97
18	0.74	0.86	0.83	0.76	0.88	1.00	0.91	1.11
20	0.82	0.96	0.66	0.88	0.91	0.87	0.95	1.14

(iv) The amounts of nitrogen absorbed in the whole rice plant in order to produce 40 *Kan* (≒ 1 *Koku*) of brown rice.

This was calculated as shown in Table 7.

(a) It has been said in Japan that this amount was nearly 1 *Kan*, but in this experiment it was seldom to be more than 1 *Kan*. H–11, O–191 and N–1 were near 1 *Kan* at the high nitrogen level.

(b) The efficiency that the absorbed nitrogen produces the brown rice decrease with the increase of the dressed amount.

(c) In H–11 and O–191 the above tendency was noticeable.

(v) Absorption rate of added fertilizer. (Table 8)

Table 8. Absorption rate of nitrogen fertilizer. (%)

	F–5	N–1	N–17	R–132	Ob–1	N 41	H–11	O–191
6	28	43	18	35	29	17	34	27
8	21	42	24	22	22	22	35	32
10	25	31	38	23	21	47	31	26
12	26	32	27	25	28	22	27	34
14	31	25	30	25	30	28	27	32
16	29	28	23	19	25	27	36	24
18	32	37	27	18	23	25	28	20
20	33	39	27	18	16	23	20	23

This rate was calculated as follows :

(N yield in dressed plot — N yield in non-dressed plot)/(Ammount of N in fertilizer)

This rate was questionable, because the amount of nitrogen absorbed from the natural supply seems not to be equal in the non-dressed plot and the dressed plot.

(a) This rate was inversely proportional to the dressed amount of the fertilizer.

(b) In F–5 and N–41 this rate increased with the increase of the dressed amount.

(c) The rate of N–1 was higher than that of F–5 and N–17 at the low nitrogen level.

4. The relation between the yield and the nitrogen content

Generally speaking, it was recognized that the weight of straw and the nitrogen content of straw and grain increased with the increase of the dressed amount of nitrogen fertilizer, but in the weight of grain some varieties increased but others decreased at the high nitrogen level.

Dr. Ishizuka[1] pointed out that there were three stages in rice growth concerning this, viz.,

(1) The stage of nitrogen starvation ..... Both weight and nitrogen content increase.

(2) The normal stage ..... The weight increases but the nitrogen content is equal.

(3) The excess stage ..... Although the nitrogen content increases, the weight decreases.

The results obtained are summarized as follows :

(i) In the straw it was recognized that there were three stages, namely :

(1) The stage of starvation (2) the normal stage (3) the stage with both nitrogen content and weight again increased. The last stage seems to be correspond to the former stage of the excess one. In Ob–1, F–5, N–41 and O–191 the stage of starvation was hardly recognized.

(ii) In the grain there was no stage of starvation but the normal stage began from the non-dressed plot. Continued from the normal stage, there were evidently the stage in which both weight and nitrogen content again increased.

There were many varieties which had excess stages, especially O–191 and H–11. But not in F–5, N–1 and N–17.

(iii) Similarly to the weight of yield, three groups were recognized.
(1) F–5, N–1, N–17, (2) R–132, Ob–1, N–41, (3) H–11, O–191.

5. Analysis of phosphor

$Mg(NO_3)_2$ was added to the sample and ashed, and then the phosphor was determined by the colorimetric method. The results obtained are shown in Tables 9–11 and Fig. 2.

Table 9. P_2O_5%

		F-5	N-1	N-17	R-132	Ob-1	N 41	H-11	O-191
straw	0	0.24	0.26	0.23	0.18	0.18	0.26	0.12	0.13
	6	0.25	0.26	0.20	0.22	0.20	0.32	0.19	0.15
	8	0.24	0.26	0.22	0.22	0.22	0.34	0.22	0.15
	10	0.25	0.27	0.25	0.21	0.23	0.33	0.22	0.15
	12	0.28	0.27	0.23	0.23	0.25	0.39	0.23	0.20
	14	0.26	0.29	0.22	0.25	0.28	0.40	0.34	0.20
	16	0.26	0.30	0.24	0.21	0.25	0.47	0.45	0.24
	18	0.29	0.35	0.27	0.24	0.31	0.43	0.41	0.27
	20	0.34	0.38	0.25	0.27	0.34	0.40	0.41	0.26
grain	0	0.60	0.63	0.58	0.74	0.76	0.66	0.63	0.53
	6	0.56	0.60	0.65	0.73	0.73	0.70	0.67	0.52
	8	0.56	0.59	0.62	0.72	0.69	0.71	0.70	0.49
	10	0.54	0.57	0.55	0.67	0.68	0.75	0.66	0.49
	12	0.56	0.62	0.63	0.73	0.68	0.70	0.64	0.50
	14	0.55	0.61	0.58	0.67	0.67	0.65	0.64	0.50
	16	0.61	0.61	0.62	0.64	0.63	0.67	0.67	0.55
	18	0.55	0.57	0.61	0.62	0.64	0.71	0.70	0.53
	20	0.53	0.55	0.59	0.63	0.59	0.70	0.70	0.42

(i) Phosphor content (Table 9)

(a) Phosphor contents (as P_2O_5) of the grain were 0.42–0.76 percent and that of straw were 0.13–0.46 percent. Phosphor content of N–41, H–11 and

Ob–1 were somewhat high, especially in the grain.

(b) Generally speaking, the phosphor content of the grian decreased with the increase of the dressed amount of nitrogen fertilizer, and that of straw increased. This variation which moved with the amount of fertilizer was much less than that of the nitrogen and silica contents.

(c) In H–11, N–41 and Ob–1 the phosphor contents of the straw increased with the dressing of nitrogen but in the others no remarkable change was observed.

(d) Phosphor contents of the grain decreased with the dressing but in F–5, N–41, an N–17 the content was almost equal and in H–11 it rather increased.

(ii) Amount of phosphor absorbed by rice plant per *Tan* (Table 10)

Table 10. P_2O_5 amounts in plants (*Kan* per *Tan*)

		straw	grain	sum	grain/straw			straw	grain	sum	grain/straw
F—5	0	0.18	0.36	0.54	2.03	Ob—1	0	0.14	0.51	0.65	3.50
	6	0.25	0.43	0.68	1.76		6	0.21	0.51	0.72	2.48
	8	0.23	0.42	0 65	1.85		8	0.22	0.57	0.79	2.62
	10	0.25	0.43	0.68	1.68		10	0.25	0.59	0.84	2.35
	12	0.27	0.51	0.78	1.88		12	0.27	0.71	0.98	2.66
	14	0.29	0.51	0.80	1.76		14	0.34	0.59	0.93	1.76
	16	0.30	0.61	0.91	2.03		16	0.31	0.55	0.86	1.78
	18	0.33	0.58	0.91	1.77		18	0.37	0.53	0.90	1.45
	20	0.47	0.54	1.01	1.16		20	0.39	0.43	0.82	1.11
N—1	0	0.16	0.29	0.45	1.79	N—41	0	0.22	0.45	0.67	2.06
	6	0.28	0.38	0.66	1.32		6	0.30	0.54	0.84	1.81
	8	0.29	0.41	0.70	1.44		8	0.37	0.56	0.93	1.53
	10	0.29	0.38	0.75	1.30		10	0.42	0.75	1.17	1.80
	12	0.31	0.44	0.75	1.42		12	0.40	0.61	1.01	1.54
	14	0.33	0.50	0.83	1.50		14	0.49	0.56	1.05	1.15
	16	0.35	0.46	0.81	1.30		16	0.60	0.50	1.10	0.84
	18	0.46	0.48	0.94	1.03		18	0.59	0.49	1 08	0.84
	20	0.53	0.47	1.00	0.88		20	0.59	0.54	1.13	0.91
N—17	0	0.19	0.40	0.59	2.06	H—11	0	0.08	0.45	0.53	5.58
	6	0.18	0.51	0.69	2.76		6	0.20	0.56	0.76	2.79
	8	0.23	0.51	0.74	2.21		8	0.23	0.63	0.86	2.67
	10	0.30	0.51	0.81	1.72		10	0.25	0.58	0.83	2.33
	12	0.25	0.55	0.80	2.16		12	0.27	0.56	0.83	1.85
	14	0.24	0.53	0.77	2.15		14	0.33	0.54	0.87	1.61
	16	0.30	0.57	0.87	1.88		16	0.50	0.56	1.06	1.11
	18	0.34	0.53	0.87	1.53		18	0.50	0.57	1.07	1.13
	20	0.35	0.56	0.91	1.62		20	0.48	0.48	0.96	0.99
R—132	0	0.16	0.52	0.68	3.28	O—191	0	0.10	0.37	0.47	3.87
	6	0.22	0.64	0.86	2.84		6	0.13	0.44	0.57	3.51
	8	0.23	0.62	0.85	2.73		8	0.15	0.44	0.59	2.82
	10	0.24	0.57	0.81	2.36		10	0.15	0.44	0.59	2.86
	12	0.26	0.65	0.91	2.55		12	0.22	0.44	0.66	1.98
	14	0.28	0.53	0.81	1.88		14	0.26	0.42	0.68	1.61
	16	0.24	0.51	0.75	2.13		16	0.28	0.36	0.64	1.25
	18	0.27	0.50	0.77	1.83		18	0.34	0.30	0.64	0.89
	20	0.32	0.44	0.76	1.37		20	0.32	0.26	0.58	0.81

(a) This amount was from 0.45 to 1.2 *Kan*

(b) Amount of phosphor in the straw increased with the dressed amount of nitrogen.

(c) Amount of phosphor in the grain had the same tendency as the weight of grain, because the phosphor contents were not greatly different. This amount increased in general, but in R–132, N–41, Ob–1, H–11, and O–191, it decreased at the high nitrogen level of fertilizer.

(iii) Grain-Straw ratio of the amount of phosphor.

(a) This ratio was 0.8–5.6 and it decreased with the increase of the dressed amount of nitrogen.

(b) H–11 and O–191 were remarkable and R–132, Ob–1 and N–41 continued normally.

(iv) The amounts of phosphor absorbed in the whole rice plant to produce 40 *Kan* (≒ 1 *Koku*) of brown rice. (Table 11)

Table 11. P_2O_5 amounts absorbed by plants in order to produce 40 *Kan* brown rice (*Kan*)

	F–5	N–1	N–17	R–132	Ob–1	N–41	H 11	O 191
0	0.33	0.35	0.30	0.34	0.33	0.33	0.26	0.21
6	0.31	0.36	0.31	0.31	0.32	0.35	0.31	0.23
8	0.30	0.36	0.31	0.34	0.35	0.37	0.33	0.23
10	0.31	0.34	0.30	0.33	0.35	0.39	0.34	0.24
12	0.31	0.35	0.33	0.36	0.40	0.38	0.34	0.26
14	0.30	0.36	0.35	0.36	0.40	0.40	0.36	0.30
16	0.33	0.37	0.36	0.33	0.36	0.48	0.44	0.36
18	0.32	0.40	0.35	0.33	0.42	0.54	0.44	0.42
20	0.36	0.41	0.35	0.35	0.43	0.48	0.51	0.35

(a) These amounts were 0.2–0.5 *Kan* and increased with the increase of the dressed amount. Especially in H–11 and O–191 this tendency was remarkable and N–41 and Ob–1 continued normally.

Table 12. SiO_2%

		F–5	N–1	N–17	R–132	Ob–1	N–41	H 11	O–191
straw	0	11.73	11.21	9.77	10.96	10.91	10.91	10.99	9.79
	6	10.16	10.23	9.94	9.87	9.63	10.10	9.63	9.36
	8	9.26	10.12	9.01	9.17	9.26	9.71	8.92	8.99
	10	9.60	9.30	7.91	9.37	8.64	9.34	8.91	8.79
	12	7.64	8.95	9.26	9.13	8.37	9.56	8.67	8.61
	14	8.61	7.46	8.26	7.82	7.48	8.37	7.78	8.41
	16	8.54	8.27	8.36	9.14	8.45	8.41	6.32	8.23
	18	8.64	7.98	9.02	9.20	7.73	8.98	7.71	8.35
	20	8.77	8.50	7.85	8.40	7.48	8.22	7.30	9.67
grain	0	3.85	3.88	3.20	3.53	3.39	3.31	3.61	3.06
	6	3.20	3.35	3.07	2.53	3.08	2.88	3.06	2.70
	8	3.12	3.15	3.01	2.71	2.52	2.76	3.19	2.74
	10	2.95	3.32	2.45	2.55	3.05	3.01	2.92	2.73
	12	2.77	3.04	3.10	2.83	2.80	2.56	3.15	2.39
	14	2.72	2.84	2.37	2.34	2.47	2.08	2.51	2.47
	16	3.09	3.01	2.85	2.60	2.77	2.37	2.29	2.42
	18	2.73	2.53	2.60	2.55	2.67	2.28	2.43	2.12
	20	3.05	2.96	2.50	2.36	2.37	2.16	2.25	2.44

Table 13. SiO_2 amounts in plants (*Kan* per *Tan*)

		straw	grain	sum	grain/straw			straw	grain	sum	grain/straw
F—5	0	8.89	1.62	10.51	0.18	Ob—1	0	8.81	2.25	11.06	0.25
	6	10.01	2.48	12.49	0.24		6	9.89	2.51	12.40	0.25
	8	8.73	2.34	11.07	0.26		8	9.11	2.08	11.19	0.22
	10	9.74	2.30	12.04	0.24		10	9.45	2.63	12.08	0.27
	12	7.30	2.50	9.80	0.34		12	9.07	2.55	11.63	0.28
	14	9.71	2.52	12.23	0.25		14	9.05	2.18	11.23	0.24
	16	9.94	3.06	13.00	0.30		16	10.34	2.42	12.76	0.23
	18	9.85	2.86	12.71	0.29		18	9.23	2.24	11.47	0.24
	20	11.96	3.11	15.07	0.26		20	8.64	1.74	10.38	0.20
N—1	0	7.03	1.76	8.79	0.25	N—41	0	9.05	2.24	11.29	0.24
	6	11.02	2.10	13.12	0.19		6	9.32	2.23	11.55	0.23
	8	11.22	2.22	13.44	0.20		8	10.61	2.17	12.78	0.20
	10	9.93	2.20	12.13	0.22		10	11.96	3.02	14.98	0.25
	12	10.33	2.19	12.52	0.21		12	9.87	2.22	12.09	0.23
	14	8.44	2.31	10.75	0.27		14	10.33	1.80	12.13	0.17
	16	9.88	2.28	12.16	0.23		16	10.73	1.75	12.48	0.16
	18	10.49	2.13	12.62	0.20		18	12.30	1.57	13.87	0.12
	20	11.83	2.53	14.36	0.21		20	11.87	1.66	13.53	0.13
N—17	0	8.25	2.20	10.45	0.26	H—11	0	7.39	2.58	9.97	0.34
	6	9.17	2.40	11.57	0.26		6	10.20	2.55	12.75	0.25
	8	9.59	2.45	12.04	0.25		8	9.36	2.86	12.22	0.30
	10	9.42	1.33	10.75	0.14		10	9.97	2.59	12.56	0.25
	12	10.04	2.71	12.75	0.26		12	10.04	2.64	12.68	0.26
	14	9.20	2.15	11.35	0.23		14	7.67	2.08	9.75	0.27
	16	10.60	2.60	13.20	0.24		16	6.90	1.90	8.80	0.27
	18	11.14	2.23	13.37	0.20		18	9.42	1.95	11.37	0.20
	20	10.83	2.36	13.19	0.21		20	8.62	1.55	10.17	0.17
R—132	0	9.86	2.49	12.35	0.25	O—191	0	7.05	2.14	9.19	0.30
	6	10.24	2.22	12.46	0.21		6	7.93	2.31	10.24	0.29
	8	9.72	2.32	12.04	0.23		8	9.25	2.42	11.67	0.26
	10	10.67	2.42	13.09	0.22		10	8.88	2.43	11.31	0.27
	12	10.45	2.52	12.97	0.24		12	9.51	2.12	11.63	0.22
	14	8.84	1.85	10.69	0.20		14	10.63	2.05	12.68	0.19
	16	10.49	2.08	12.57	0.19		16	9.91	1.57	11.48	0.15
	18	10.56	2.08	12.64	0.19		18	10.39	1.21	11.60	0.11
	20	10.18	1.66	11.84	0.16		20	11.22	1.50	12.72	0.13

(b) In H–11 and O–191 this amount was least at the low nitrogen level but in H–11 an N–41 it reached the maximum at the high nitrogen level.

(v) Generally speaking, from the results of phosphor analysis, H–11 and O–191 were characteristic.

6. Analysis of silica

The results obtained are given in Tables 12, 13 and Fig. 2.

(i) Silica contents of both grain and straw decreased with the increase of the dressed amount of nitrogen.

(ii) Silica content of the straw was about 10 percent and a remarkable decrease was recoginzed in F–5, N–1. Ob–1 and H–11.

(iii) Silica content of the grain was 2–4 percent and in F–5 there was noticed an increase with the dressing of the nitrogen.

(iv) The amounts absorbed by rice plants per *Tan* reached to 10-15 *Kan*.

(v) The amounts of silica in the straw increased with the increase of the dressing amount, but in Ob–1 and R–132 the degrees of increasing were small.

(vi) The amounts in the grain were nearly equal, but F–5 and N–1 had the tendency to increase while R–132, N–41, Ob–1 H–11 and O–191 showed a tendency to decrease.

(vii) The grain-straw ratios of absorbed amount were nearly equal in F–5, N–1, N–17 and Ob–1 but that in R–132, N–41, H–11 and O–191 were inclined to decrease.

(viii) Generally speaking, there was recognized no characteristic in the varieties except F–5, N–1, H–11, and O–191.

Summary

(1) Response of the rice plant varieties upon the amount of dressed nitrogen were examined from the stand point of yield and analysis of nitrogen, phosphor and silica.

(2) Plots dressed by ammonium sulphate fertilizer were 0, 6, 8, 10, 12, 14, 16, 18, and 20 *Kan* per *Tan*.

Varieties used were F–5, N–1, N–17, R–132, Ob–1, N–41. H–11 and O–191. They were obtained by crossing method at the agricultural experiment station.

(3) The increase in the numbers of parnicle exceeded the height with the increased of the dressed fertilizer.

(4) With an increase of the dressed amount of fertilizer, the weight of the straw increased, but in the grain of some varieties (F–5, N–1 and N–17) there was an increase while in other varieties a decrease, especially H–11 and O–191, was remarkable.

(5) The varietal order of the grain yield differed according to the dressed amount, at the low nitrogen level the yields of H–11 and O–191 were large and F–5 and N–1 were small, but at the high level F–5, N–1 and N–17 were large and H–11 and O–191 were samll.

(6) Nitrogen contents were 0.8–1 percent in the grain and 0.4–0.8 perecnt in the straw; phosphor contents were 0.4–0.8 percent in the grain and 0.1–0.5 percent in the straw; and the silica contents 2–4 percent in the grain and 7–12 percent in the straw.

(7) Nitrogen contents of both grain and straw and the phosphor contents of straw had the tendency to increase, but phosphor contents of the grain and silica contents of both grain and straw decreased by increasing the dressed amount. The degree of increase or decrease differed according to the varieties.

(8) To produce 40 *Kan* (≒ 1 *Kan*) of brown rice, the amount of nitrogen absorbed was 0.4–1.2 *Kan* and that of phosphor, 0.3–0.5 *Kan*.

(9) Grouping the varieties from the results of yields and analysis, the fol-

lowing is obtained :

1st group. F–5, N–1 and N–17.

2nd group. R–132. Ob–1 and N–41.

3rd group. H–11 and O–191.

F–5, H–1 and O–191 are characteristic ; the 2nd group is the intermediate one and in one property some varieties resemble the lst, while in another property the other varieties resemble the lst.

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Physiological Behavior of Hydrogen Sulfide in the Rice Plant*

Part I.

Effect of Hydrogen Sulfide on the Absorption of Nutrients

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(Received April 10, 1953)

I. Introduction

Reports have been published to date on several researches on the harmful effect of hydrogen sulfide on the rice plant, which is considered as one of the causes of the phenomenon commonly referred to as "akiochi," including the one by Kumada[1] with emphasis on its relationship to the roots of the rice plant from the point of view of rhizosphere. Among other researches, interesting are a series of studies reported by Mitsui and co-workers[2] under the title "Dynamic Studies in the Nutrient Uptake by Crop Plants," the one by Baba et. al.[3] on the inhibition of absorption of nutrients caused by H_2S, and the one by Suzuki, Honya et. al.[5] on this kind of effect in relation particularly to absorption of Mn. Other studies, in which approach was made to the subject from the angle of the chemical composition of the rice plant, include the ones by Yamane[7], Suzuki and Maeda[6] and other workers[4]. In these studies, the harmful effect of H_2S was estimated by the lowered efficiency of nutrient uptake or lack of certain elements of the plant, which is considered to be caused by H_2S. These studies are important in view of the efforts in relating Shioiri's idea of the "degraded paddy field" to the rice plant.

Mitsui explained that the hydrogen sulfide inhibits respiration of roots and, consequently, the so-called metabolic absorption so that inhibition of selective absorption of nutrients occurs to the plant, resulting in a nutritional deficiency peculiar to the "akiochi." In any case, it is of great significance from the standpoint of nutritional biology of the rice plant to find out in what ways the

* The 96th report of the Institute for Agricultural Research, Tohoku University. (1953)

hydrogen sulfide affects the metabolism of elements in the rice plant.

At our station, we conducted the experiment which this report concerns by the root separation method for the purpose of knowing, as the first step of clarifying the mechanism of effect of H_2S, whether the phenomenon of H_2S injury is caused only by deficiency of nutrients resulting from the inhibition of nutrient uptake, or it comes out as a sequence of the secondary effects of the direct injury caused by H_2S which bring about a change in the metabolism of elements in the rice plant itself. The experiment was conducted by the root separation method, in which the roots of each plant were separated to both opposite sides in order to estimate what influence the inhibition of nutrient uptake by the roots on one side will give on the process of metabolism of elements in the rice plant from the change in efficiency of absorption of nutrients in the roots on the other side and also in the chemical elements of the plant. The present report, as Part I, will concern some of our results recently obtained.

II. Method of Experiment

Hotbed-grown rice seedlings of Variety Norin No. 16 (height : 18 cm) were brought to water culture, each plant being put in a 1/50,000 *tan* pot with the ordinary culture solution in it. The culture solution used was of the following composition :

Composition of the culture solution (mg/*l*)

N :	40	MgO :	30
P_2O_5 :	20	Fe_2O_3 :	5
K_2O :	20	Mn_2O_5 :	5
CaO :	20		

The plants were cultured with the perfect culture solution until early July. Then, around mid-July, the roots of each plant were separated to opposite sides for dipping in the solution in the semi-cylindrical glass containers set inside each pot for treatment beginning about the primordial stage of the plant. All the plants were divided into two groups, and treatment was started from July 22 for Group No. 1 and from July 29 for Group No. 2, after the same pattern of series division for both groups, as shown below. Duration of each treatment was forty-eight hours as a rule, and while no treatment was conducted, the plants were cultured with the perfect culture solution. Each series consisted of six individual plants.

Series A — Control

Series B — Both sides treated with H_2S

Series C — One side treated with H_2S

Series D — Roots on one side cut halfway

Series E — No nutrient in solution on one side

On series B, the roots on the both sides were treated with H_2S. The concentration of H_2S in the solution used was decided on the basis of the information previously obtained from the preliminary studies with seedlings on the relationship between the H_2S concentration and the degree of inhibition of nutrient uptake. The solution was prepared by adding 10 cc of H_2S-saturated solution to 900 cc of the ordinary culture solution.*

On series C, the roots on one side were kept in the perfect culture solution while those on the other side were given the same treatment as on series B. This was for the purpose of knowing what effects the treatment of the roots on one side will produce on those on the other side.

On series D, the roots on one side were cut at the point 5 cm below the base of the roots so that partial lack of nutrients might occur because of inhibited nutrient uptake by a reduced area of absorption surface of the roots.

On series E, the roots on one side were given no nutrients at all but water in order to effect a complete lack of nutrients.

The roots on the left and right sides will be indicated by the subscripts 1 and 2, respectively, in the following parts of the present report. i.e., A_1 A_2, B_1 B_2, ... E_1 E_2. The subscript 2 indicates treated roots, except for A_2. The treatment was repreated according to the following schedule :

Dates of treatments.

Groups / Times of Treatment	Group No. 1	Group No. 2
1st	July 22–24	July 29–31
2nd	August 2– 4	August 7– 9
3rd	August 12–18	August 14–16
4th	—	August 23–25

III. Results

Though detailed observations about the growth of the plants are to be given later, a few points will deserve brief mentioning here. The influence of H_2S made its appearance on series B a week after the treatment. The lower leaves died and the roots were white with few hairs, and soft and weak, obviously indicating the injury caused. On series C, the treated roots gave the appearance similar to that of the roots on series B, but no significant injury was observable on the top of plant. Consequently, it is difficult to make comparison among series C, D, and E with respect to the relationship between lack of nutrients and harmful effects of H_2S on the basis of the observations of general appearance of the plants. The

* The concentration of S'' was 28.3 p.p.m. on July 22, when 10 cc of H S-saturated solution was added to 900 cc of the culture solution. It reduced to about 5 p.p.m. after the two full days of use for treatment.

only thing to be noted was that growth of the plants on these series were lagging behind as compare with the control series toward the end of the experiment period. (Table 1)

Table 1. Growth of rice plants.

Date	Growth indicated by :	A	B	C	D	E
July 29	Height (cm)	74.1	74.5	75.1	75.3	75.0
	No. of tillers	15.0	14.5	15.3	13.8	14.1
Aug. 14	Height (cm)	87.8	80.1	83.6	84.8	84.6
	No. of tillers	17.5	14.5	15.3	15.6	14.1
Aug. 23	Height (cm)	90.3	75.6	84.8	84.6	86.1
	No. of tillers	16.8	13.1	15.0	14.5	13.6

Nutrient uptake of the roots on each lot was determined indirectly by analysis of the culture solution, that is, the amount of elements absorbed was determined on the basis of the balance between the amount of each nutrient in the culture solution before use and thatafter use. The methods listed below were used for analysis for different nutrients. Some error may enter in such indirect determination of the amount of each nutrient absorbed by the method of analyzing the culture solution, owing to the interaction between H_2S and other inorganic matters in the culture solution. But in estimating the amount of nutrients absorbed by seedlings by analysis of the culture solution with H_2S removed after treatment with it, we observed in our results a same tendency as while H_2S had been in it. The above possible error, therefore, will be negligible.

Methods used for
quantitative analysis of various nutrients

NH_3–N ..... Kieldahl's method
NO_3–N ..... Miyake's color method
P_2O_5 ..... Truog-Meyer's method
K_2O ..... Dipicrilamine method
MnO ..... Super-iodate method
MgO ..... Color method with titanic yellow
CaO ..... Tisdall's micro-quantitative analysis method

The results of the analysis show the amounts of nutrients absorbed per pot by the roots on each of opposite sides on each series.

The data relative to inhibition of nutrient uptake are given in Tables 2, 3, 4, 5, 6, 7, and 8, and Figure 1. As separation of roots involves much of individual variation, as will be seen from the figures for A_1 and A_2 on the control

series, and it is difficult to make an accurate quantitiative comparison between the results of different treatments, it would be reasonable just to pick up what is considered as common tendencies for both Groups No. 1 and No. 2 in relation to each of different treatments.

Group No. 1 happened to be treated always in fine weather while Group No. 2 on cloudy or rainy days. As a result, there was a marked difference in the absorption of H_2O, as will be seen from the data for the second treatment of Group No. 1 and the first treatment of Group No. 2 (Tables 3 and 5 and Figure 1). In the nutrient uptake, however, there was observed no significant difference, confirming the established opinion that no parallel relationship exists between the amount of moisture absorbed and that of nutrients.

Table 2. Inhibition of nutrient uptake caused by the first greatment of nroup No. 1
(July 22–24, 1952) Weather : fine

Series	Types of treatment	Amount of each nutrient absorbed per pot (mg)							
		K_2O	NH_3	CaO	MgO	MnO	P_2O_5	NO_3	H_3O*
A	A_1 No treatment	15.9	14.5	3.1	3.1	0.4	12.9	8.1	160
	A_2 No treatment	16.8	12.3	1.7	4.2	0.4	10.7	8.4	126
B	B_1 H_2S	−0.1	6.7	5.9	2.2	0.2	3.7	6.0	76
	B_2 H_2S	2.8	6.3	5.2	2.5	—	4.8	6.0	77
C	C_1 No treatment	16.7	15.3	2.8	4.5	0.3	12.6	8.8	220
	C_2 H_2S	2.5	6.8	5.6	4.3	0.4	4.5	6.2	107
D	D_1 No treatment	17.1	15.3	6.7	8.4	0.7	13.5	9.2	289
	D_2 Partial cut	7.9	8.7	4.4	6.4	0.4	7.2	7.7	112
E	E_1 No treatment	17.5	16.5	2.8	5.7	0.4	10.7	8.9	167
	E_2 H_2O	—	—	—	—	—	—	—	165

* Unit is cc for H_2O.

Table 3. Inhibition of nutrient uptake caused by the second treatment of group no. 1
(August 2–4, 1952) Weather : fine

Series	Types of treatment	Amount of each nutrient absorbed per pot (mg)							
		K_2O	NH_3	CaO	MgO	MnO	P_2O_5	NO_3	H_2O*
A	A_1 No treatment	12.9	11 8	0.7	1.5	0.5	12.7	6.0	165
	A_2 No treatment	12.5	10.0	2.3	2.4	0.4	11.9	5.1	150
B	B_1 H_2S	2.3	2.4	1.7	—	0.3	1.7	1.5	85
	B_2 H_2S	2.9	2.5	2.0	0.4	0.3	2.3	1.7	99
C	C_1 No treatment	12.8	13.2	0.1	1.0	0.4	12.8	5.8	139
	C_2 H_2S	4.3	3.6	2.6	1.3	0.4	3.4	4.2	122
D	D_1 No treatment	13.4	15.0	—	1.3	0.2	13.7	6.0	136
	D_2 Partial cut	5.8	4.3	3.7	4.1	0.4	4.5	5.0	130
E	E_1 No treatment	12.8	12.7	0.4	0.1	0.3	11.0	5.8	88
	E_2 H_2O	—	—	—	—	—	—	—	120

* Unit is cc for H_2O.

Table 4. Inhibition of nutrient uptake caused by the third treatment of group No. 1
(August 12–18, 1952) Weather : fine

Series	Types of treatment	Amount of each nutrient absorbed per pot (mg)						
		K_2O	NH_3	CaO	MgO	P_2O_5	NO_3	H_2O*
A	A_1 No treatment	10.7	8.2	1.2	1.4	5.4	3.0	154
	A_2 No treatment	10.7	7.8	1.3	2.0	5.4	2.7	148
B	B_1 H_2S	1.7	3.4	1.1	−1.4	1.4	0.8	83
	B_2 H_2S	3.9	3.3	2.1	−1.3	2.8	1.5	85
C	C_1 No treatment	11.7	8.5	−1.1	−1.3	5.6	3.2	161
	C_2 H_2S	2.6	4.1	2.6	2.8	4.7	1.6	119
D	D_1 No treatment	11.4	8.6	−0.6	−0.9	5.9	3.4	161
	D_2 Partial cut	4.1	5.7	5.9	2.8	4.6	2.8	159
E	E_1 No treatment	10.1	9.5	2.2	1.5	5.4	3.4	13?
	E_2 H_2O	—	—	—	—	—	—	160

* Unit is cc for H_2O.

Table 5. Inhibition of nutrient uptake caused by the first treatment of group no. 2
(July 29–31, 1952) Weather : cloudy & rain

Series	Types of treatment	Amount of each nutrient absorbed per pot (mg)							
		K_2O	NH_3	CaO	MgO	MnO	P_2O_5	NO_3	H_2O*
A	A_1 No treatment	11.8	16.0	0.4	4.2	0.15	9.7	7.3	101
	A_2 No treatment	12.8	15.6	1.9	3.3	0.18	8.6	6.5	98
B	B_1 H_2S	1.0	4.7	2.8	0.9	0.06	−0.5	3.6	50
	B_2 H_2S	1.3	4.9	2.8	3.2	—	−0.4	2.8	53
C	C_1 No treatment	13.4	20.0	−0.3	3.4	0.23	10.6	7.0	105
	C_2 H_2S	1.4	5.2	3.8	3.1	0.14	0.7	5.8	91
D	D_1 No treatment	12.5	17.3	6.5	3.8	0.14	9.6	5.5	84
	D_2 Partial cut	4.6	7.5	2.6	4.7	0.11	3.6	4.1	85
E	E_1 No treatment	12.8	18.6	2.2	4.9	0.13	9.9	8.7	113
	E_2 H_2O	—	—	—	—	—	—	—	98

* Unit is cc for H_2O.

The treatment was repeated for each group, as mentioned above, three or four times in a period of about one month between the primordial stage and heading of the rice plant. It was observed that the degree of injury tended to reduce with delay of time of treatment after the primordial stage. Particularly, only a relatively low degree of inhibition of nutrient uptake occurred by the third treatment of Group No. 1 with a larger amount of H_2S than ever, conducted every other day for one week. This naturally indicates existence of a certain relationship between the inhibition of absorption by H_2S and the stage of growth of the plant.

The order of the different nutrients in the degree of inhibition of absorption thereof, observed in our experiment, was as follows, showing an agreement with that reported previously by Mitsui et. al. and also that observed in our

Table 6. Inhibition of nutrient uptake caused by the second treatment of group no. 2
(August 7-9, 1952) Weather : rain & cloudy

Series	Types of treatment	Amount of each nutrient absorbed per pot (mg)						
		K_2O	NH_3	CaO	MgO	P_2O_5	NO_3	H_2O*
A	A_1 No treatment	12.7	11.0	−0.1	2.4	10.3	5.3	97
	A_2 No treatment	12.2	11.5	0.1	3.7	9.1	5.6	102
B	B_1 H_2S	1.1	3.5	3.8	−2.0	1.4	2.1	51
	B_2 H_2S	3.0	3.5	3.5	−1.3	1.3	1.7	48
C	C_1 No treatment	12.8	13.7	−0.9	0.2	9.6	5.6	88
	C_2 H_2S	2.3	3.1	3.0	1.3	1.6	2.0	64
D	D_1 No treatment	11.1	9.4	1.0	2.0	6.9	4.8	80
	D_2 Partial cut	5.9	6.8	0.4	5.1	5.3	4.5	80
E	E_1 No treatment	13.1	13.5	0.5	1.9	9.9	4.7	88
	E_2 H_2O	—	—	—	—	—	—	88

* Unit is cc for H_2O.

Table 7. Inhibition of nutrient uptake caused by the third treatment of group no. 2
(August 14-16, 1952) Weather : cloudy

Series	Types of treatment	Amount of eacc nutrient absorbed per pot (mg)				
		K_2O	NH_3	CaO	P_2O_5	H_2O*
A	A_1 No treatment	14.7	11.6	2.1	10.3	172
	A_2 No treatment	15.0	11.9	2.1	10.7	170
B	B_1 H_2S	2.7	4.2	2.4	2.1	82
	B_2 H_2S	2.8	4.1	1.7	2.5	69
C	C_1 No treatment	15.8	12.9	−0.7	6.7	136
	C_2 H_2S	3.1	4.4	3.3	2.7	119
D	D_1 No treatment	15.4	12.2	−1.0	8.2	136
	D_2 Partial cut	5.2	6.6	2.1	4.5	133
E	E_1 No treatment	14.6	13.2	1.1	9.2	131
	E_2 H_2O	—	—	—	—	109

* Unit is cc for H_2O.

experiments with seedlings* :

$$P_2O_5 > K_2O > NH_3 > NO_3 \fallingdotseq H_2O$$

On the other hand, absorption of CaO and MgO on some occasions seemed to be increased by H_2S treatment. This phenomenon is probably a one which supports the observation that, the active absorption being inhibited, the merely physical absorption becomes more important.[2] This increase in the amount of CaO and MgO absorbed was found also in D_2, the roots cut off partially. It seems that cutting of the roots halfway resulted not only in a reduced area of absorption surface but also in a change in mechanism of absorption. It is not clear whether this was because of removal of the end of the root which is considered as the place

* Not published yet.

Table 8. After-effect of 1st to 3rd treatments of group no. 2**
(August 23-25, 1953) Weather: rain & cloudy

Series	Types of treatment	Amount of each nutrient absorbed per pot (mg)					
		K_2O	NH_3	CaO	P_2O_5	NO_3	H_2O*
A	A_1 No treatment	8.8	6.5	−0.7	4.0	1.4	57
	A_2 No treatment	9.0	6.4	0.0	3.3	1.2	52
B	B_1 No ttreatmen	2.5	2.2	0.7	0.8	0.2	30
	B_2 No treatment	3.3	2.5	0.2	0.7	0.2	24
C	C_1 No treatment	7.5	6.3	−0.4	2.7	1.4	59
	C_2 No treatment	2.5	2.7	0.8	1.5	0.1	30
D	D_1 No treatment	9 1	6.4	0.1	3.1	1.2	63
	D_2 No treatment	4.9	4.1	0.7	3.0	0.3	55
E	E_1 No treatment	8.1	7.5	0.0	3.3	1.7	53
	E_2 No treatment	—	—	—	—	—	42

* Unit is cc for H_2O.

** Following the 3rd treatment of Group No. 2, absorption of nutrients was measured after changing the culture solutions, with no H_2S treatment, in order to estimate the after-effect of the previous treatments.

of active absorption or of cutting itself.

The non-treated roots (C_1, D_1, and E_1) corresponding to the treated ones on the other sides showed no influence of treatment in their activities of absorption nor in their appearance indicating that treatment of the roots on one side does not influence the efficiency of nutrient uptake per unit of the roots on the other side. But the half-cut roots D_2 showed a reduced amount of nutrient uptake in all the cases but no change in moisture absorption, supporting the reports by Broyer, Hoagland[11], and Kramer[10] that the amount of moisture absorption by roots changes parallel with the amount of transpiration of moisture from the plant.

The degree of inhibition of nutrient uptake varied with the treated roots in the following order:

$$B_2 > C_2 > D_2$$

The highest degree of inhibition occurred to B_2 with the roots on the other side, too treated with H_2S, followed by C_2 with the non-treated roots on the other side. The least inhibition was observed in D_2, which was cut off partially to reduce the area of surface of absorption. This fact indicates that the inhibition of active absorption was caused by H_2S. Also, the fact that, in comparing growth on Series B and Series C, an apparently good growth was observed on Series C where the roots on one side were left non-treated, while a considerable injury marked Series B, may present an evidence for that, as is the case with the effect of Cu according to Ishizuka[8], a larger part of the injury by H_2S is limited to the roots. However, unlike the case with Cu, it is very doubtful if the effects of H_2S on the top of the plant are to be produced simply by these relations. That is to say that lower degree of inhibition with C_2 than B_2 is suspected to have been becuase of possible

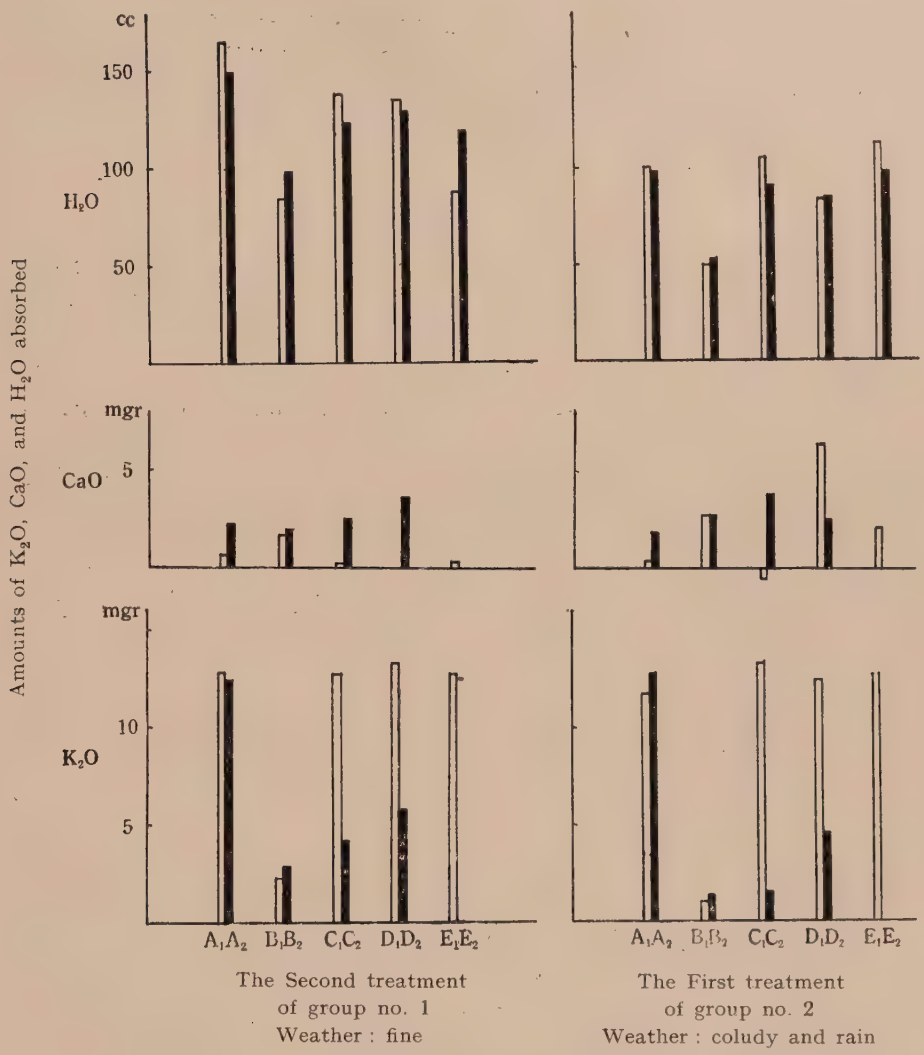

Figure 1. H_2S Caused Inhibition of Absorption of K_2O, Cao, and H_2O.

favorable effects of failure of treatment of the roots on one side on the top of the plant, consequently offsetting a part of the H_2S-caused inhibition. Is it not true in this case, as Kramer[9] claims that the excess-moisture injury is related to the nutrition of the top of the plant, the nutrition of the top part can affect the degree of the injury caused by H_2S.? It seems, in other words, that the direct harmful effect of H_2S spread partly to the top of the plant, but its action was affected by the nutritional level of this part, resulting in a seemingly good growth on Series C and the contrasting marked injury on Series B.

In the influence of H_2S inside the plant there was a significant difference

between Series C, for which no noticeable effect was observable from the outward appearance of the plants, and Series D or E with a short supply or complete lack of nutrients. This points to a possible direct effect of H_2S injury to inhibit normal process of metabolism of elements, besides its effect of causing a mere nutritional deficiency, suggestiong complexity of the subject.

IV. Summary

In order to get information on the mechanism of action of H_2S in the rice plant, a comparative study was made by the root separation method on the cases of lack of nutrients and nutritional injury caused by H_2S, as indicated by inhibition of nutrient uptake.

The roots of the rice plants were separated to both opposite sides, and the treatment of a duration of 48 hours was conducted, dividing all the plants into five different series as listed below, three or four times during the period between the primordial stage and heading of the plants. Measurement was made of the amounts of various nutrients absorbed after each treatment.

A (Control)
B (Roots on the both sides treated with H_2S)
C (Roots on one side treated with H_2S)
D (Roots on one side cut partially)
E (Roots on one side supplied with no nutrients at all)

The results are summarized as follows :

1. The degree of inhibition of nutrient uptake caused by H_2S varied with the kind of nutrient in the order :

$$P_2O_5 > K_2O > NH_3 > NO_3 \fallingdotseq H_2O$$

There was observed a tendency of increase in absorption of CaO and MgO.

2. There were indications that the degree of inhibition of nutrient uptake, except for absorption of H_2O, is related to the stage of growth of the plant.

3. The treatment of the roots on one side did not affect the efficiency of nutrient uptake by the roots on the opposite side of the same plant.

4. The degree of inhibition of nutrient uptake by the H_2S-treated roots varied with the series in the order :

Series B>Series C>Series D.

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The Distribution of the Injured Stems in the Rice-field Attacked by Rice Stem Borer, *Chilo simplex* Butler*

(In the case of the period of the first generation of the insect)

Mikio KANTA

(Received February 10, 1953)

I. Preface

That the type of the distribution and its spatial construction on the noxious insects or on the injury of crops by them should be cleared up and the statistical principle on the quautitative structure of the population distribution should be pursued, it is not only very interesting subject from the viewpoint of accountancy itself, but also fundamentally very contributive of population ecology, to the injury estimation, and to the designing of tentative field experiments.

I can write down the imporatnt warks of Beall[3] (1935), Bartlett[4] (1936), Beall[3] (1940), Bliss[5] (1941, 1945) and Bowen[6] (1947), as well as of Student[1] (1907, 1919), Neyman[2] (1939), as for the theoretical study on the distribution of the insect population.

In Japan, the problem of the population-distribution is recently increasing its importance from the statistical point of yiew, and vet not so many research works were given to this kind of subject. With respect to the rice stem borer, I can only put down the research works of Iih[7] (1951) and Miyamoto[8] (1951) on the distribution of the number of injured stems per hill, of Koono and others[10] (1952) on the distribution type of the number of imagos per hill, and of Kato[9] (1952), in the case of the paddy borer, *Schoenobius incertellus* Walker, on the distribution of the egg mass and the moth.

I[11] have previously tried some statistical researches on the distribution type of the injured ears occurred by the rice stem maggot, *Chlorops oryzae* Matsumura, from my stand point of the tentative designing of field experiments on the insect.

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* The 89th report of the Institute for Agricultural Research, Tohoku University (1953).

I tried to give some analysis and considerations to the rare events from the statistical and analytical point of view, as I got an un expected chance to further examine the distribution type of the injury by the rice stem borer owing to the favour of the Shizuoka Prefectural Experiment Station of Agriculture.

The data for this research came from the summary of the results of "The Basic Investigation on the Amount of Breaking-out at Paddy Fielf of the Rice Stem Borer and The Examination of their Injury" which was actually examined in Tawara-mura village, Iwata-gun, Shizuoka Prefecture, 1951, under the auspices of the Research Section of Agricultural Extension Bereau of Ministry of Agriculture and Forestry. They are made up of the "Research Data (2), The Investigation Table of the Number of the Injured Stems in the Three-plant-planting Hill Unit, which is part of the summary. As the investigation was not intended directly to examine statistically the distribution type of the injured stems, it could not produce so good result. Hoping, however, that it should be helpful at all to the future researches, first of all I want to report here the outline of the results obtained.

I must give my hearty thanks to Mr. Yugo Ueda, the technical officer of the Shizuoka Prefectural Experiment Station of Agriculture, who urged me to give analysis and considerations to the nature of the distribution of the injury by the insect, and the writer also wishes to express his thanks to Mr. N. Takahashi for his valuable aids.

II. Materials and methods

This resarh work, as I already refered, is what some analysis and considerations were given statistically from the standpoint of the distribution type of injury to the "Investigation Data (2)", which was brought out of the data of "The Basic Investigation on the Amount of Breaking-out at Paddy Field of The Rice Stem Borer and the Examination of their Injury", part of the extermination and prevention experiment aganist the rice stem borer given by the Shizuoka Prefectural Experiment Station at Tawara-mura village, Iwata-gun, Shizuoka Prefecture, in 1951,.

The extracts out of the outline about the designing of the investigation paddy field and about the method of examining injury, which the data include, are as follows :

The another coud fortunately received some references from Mr. Ueda in some of our private letters who was one of the officials in charge for this research. Here are added some item of them too ;

1. Place for the Investigation

A farmer's paddy field at Hikoshima, Tawara-mura, Iwata-gun, Shizuoka prefecture : Tawara-mura is well-known as the place where rice-stem borers break out in paddy field every year.

2. Rice-field used for the investigation.

The field used for this investigation is one block, 14 *ken* long and 6 *ken* wide, of a cultivated rice field of 1 *cho* 2 *tan* square.

3. Outline of the cultural method.

The rice variety which was planted in the field was Norin No. 8, and the plants were planted three plants per hill. The cultural method was performed generally in the manner of this district. The maine tims of it are as ollows :

Seeding date : May 14
Seeding density : 2.5 *go* per *tsubo*
Transplanting date : June 25
Row spacing : 9 *sun*
Spacing in the row : 8.5 *su*
Yielding date : October 22–26

4. Growth of the rice plants in the investigation field.

The comparatively reasonable weather in the period of seedling stage bring up healthy seedlings. After the transplanting, the weather condition was bud, since it was high in temperature, poor in sunny days, and the tillering was late on account of much rain. The fine weather came back and it was suddenly high in temperature since the end of July. The plants, therefore, were rapidly raised. But they showed themselves rather weak for their Plant hight. Rice wilitng disease, *Piricularia oryzae*, broke out in a part of this district but not in the investigation field. In August it was a little higher than the average year in temperature and the highest period of heading was just before and after 29th of the month. In September, low in temperature, much in rainfall, and the plant growth after heading was rather spoiled. Since the rice leafhoppers, *Sogata furcifera* Horvath, broke out towards the end of August, the oil-extermination, of petroleum, was given against it, September 4th. The rice variety, Norin No. 8, planted in the investigation field is classified as the early maturing variety in this district. Ahead of all other surrounding fields, it finished its heading. Therefore a protecting net was used against the sparrows injury. And in the middle of September, a flight of herons came down to the investigation field, without giving so much injury, except some rice stem-break.

5. The aspects of the breaking out of the rice stem borer at the investigation field.

The condition of the breaking out of the rice stem borer at the investigation field in 1951 is shown in Figure 1 and in Table 1.

The biginning date of breaking out of the insect was late both in the first generation period and in the second. The extermination number of the insect this year was less than that in the first generation period and more than that in the second generation period last year (1951). The first arrival and the 5% arrival of the insect at paddy field were early in the first generation period and the breaking out of the insect after that was notably late ; very late in the date of the

top number and the date of end of breaking out.

The extermination number of the insect after the transplanting which is connected with the injury of the irce plants, was three times as many as that of last year (1951) ; (1750 in this year and 494 in last year). There was great injury in the whole neighbourhood of the place and some paddy fields near the examination field even lost their stands at places.

The breaking out of the insect through the second generation period was rather late just as that in the first generation period. The extermination number of the insect was about twice as many as that in last year, the injury of the rice plants through the second generation period was far more than that in the first generation period, and many rice stems were broken by the wind when the typhoon Ruth passed through the district (Oct. 14th-15th). The disperasion of the imagos was so extreme through the second generation period that healthy plant could scarcely survive.

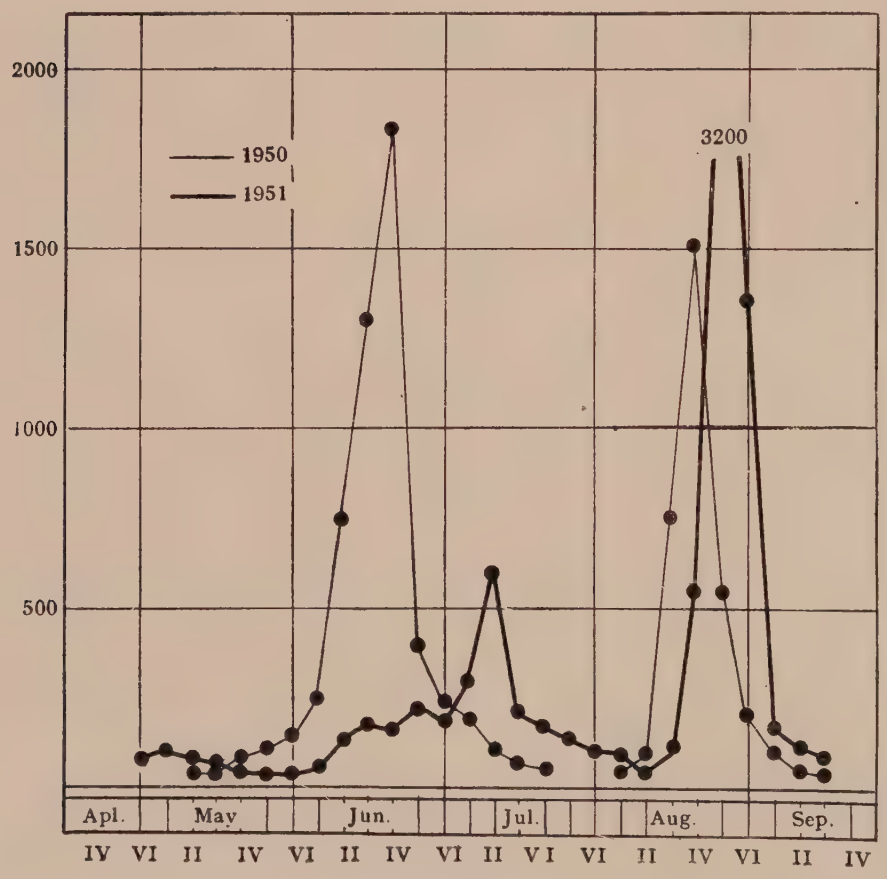

Fig. 1. The extermination number of the insect in every 5 days.

Table 1. The aspects of the bresking-out of the rice stem borer at Shizuoka prcfecture.

Generation	Location	Tawara		Shizuoka		Yoshikawa	
	Item	1951	1950	1951	ave. year	1951	1950
1st gener.	Biginning date of flight	4–25	5–6	4–20	4–26	5–6	4–17
	Date of 5% flight	5–30	6–3	5–3		6–7	5–3
	Date of highest flight	7–9	6–20	6–8	6–20	6–22	6–21
	Date of 95% flight	7–18	7–1	7–18		7–15	7–4
	Ending date of flight	8–3	7–18	7–31	7–19	8–2	7–19
	Period of flight	88	63	79	62	78	80
	Total numbers of the mothes exterminated	2788	5316	1233	1233	3062	2685
	Highest exterminated number of mothes in one day	352	805	69		109	
2nd gener.	Bigining date of flignt	8–4	8–4	8–8	8–10	8–6	8–2
	Date of 5% flight	8–18	8–13	8–18		8–15	8–10
	Date of highest flight	8–22	8–17	8–23	8–22	8–25	8–16
	Date of 95% flight	8–31	8–29	9–1		9–13	9–9
	Ending date of flight	9–28	9–18	9–23	9–15	10–9	9–25
	Period of flight	53	38	44	28	43	42
	Total numbers of the mothes exterminated	5569	3084	289	449	415	229
	Highest exterminated numbers in one day	1419	448	199		39	

Note : The figures 4, 5, 6, 7, 8, 9 and 10 in the table show the mouth April, May, June, July, August and Sepember, accordingly.

As I have pointed out above, the year, 1951, was very notable in the respect of injury. These research data, therefore, should be considered as an exceptionally remarkable case of injury.

6. Examination Method.

The examination was given totally five times through the first and second generation periods. The number of the whole stems, of the injured stems, and of the dead stems (in the first generation period) or the half-heading ears or the completely whitened ears (in the second generation period) ; for these three subjects every 4000 hills within the field were examined without cutting.

After the harvest, every 50 hills were threshed and refined, and their unhulled rice weight and husk weight were both measured. Again, the completely refined and the half-refined rice were separated with by husk-removing, wind-admitting, and sifting. And the weight of the groups was measured.

The dates for the examination at the field are as follows :

The 1st examination (the first generation period) : July 14th
The 2nd examination (the 1st generation period) : July 26-27th
The 3rd examination (the 1st generation period) : Aug. 8–10th
The 4th examination (the 2nd generation period) : Sept. 7–10th
The 5th examination (the 2nd generation period) : Sept 27–29th

III. The distribution type of the number of the injured stems per hill

In the case of the occurrence number of some phenomenon, a situation in which the phenomenon could possibly occur has such an extension as time or space and the occurrence itself of the phenomenon is always discretive. From such a point of view, the occurrence of the phenomenon is regarded as a rare phenomenon. (Kitagawa, 1951). For example ; the distribution of the individual living thing or the distribution of number of the injured stems attacked by noxious insects. It has been viewed in this light, attempted for a long time to apply the statistical rules of a rare phenomenon to the distribution by regarding it as a statisitcal phenomenon. Many statistical models for diverse distributions have been given by meny researchers and the most fundamental of them is the Posison distribution. When an actual distribution shows fair fitness to the Poisson type, the statistical treatment of the data is easy, and very convenient in its practical use as its sampling and others become simple. I saw that the distribution of the injured ears attacked by rice stem maggot shows fair fitness fundamentally to the theoretical model of the Poisson distribution for an example that the distribution of the injured stems attacked by noxious insects in the rice field adapts to the Poisson distribution (Kanda[11] 1951). Generally, the three important points of homogeneity, independency, and discretiveness should be fulfilled for necessary conditions in order to get a good result by taking up the Poisson distribution for the theoretical model. It is the same with other theoretical models ; they have many premises in the bottom.

In case of trying to apply a theoretical model to an actual distribution, therefore, necessary considerations must be taken to the mechanism always providing for each distributive phenomenon, and a theoretical model to show fair fitness with the distributive mechanism must be discovered. When a living thing takes its place somewhere, for example, the place will hardly be fixed in no connection with the factors in its environment, and still in case of the relation of the individual living thing, the place of an individual living thing may not be fixed without relation to that of another because of its inclusive or exclusive nature. Even if the Poisson distribution which contains severe restrictions about the independency of the occurrence of phenomena were applied to those things which are not independent each other, it would be not always successful as a natural conclusion.

In case of the rice stem borer the eggs laid generally on the surface of the leaf-edge of the rice-plant in the first generation period in an egg mass consisting of 50–60 eggs. Concerning the population of the imago, accordingly, which are hatched from an egg mass, every situation occupated by an imago is related with the others through a phenomenon of egg laying, they do not seem to be independent

in the least with each other. And exceptionally if the migratory amplification of the imagos which were hatched from an egg mass could be infinite, then every situation of imagos would become quite unrelated to that of the place of the egg mass. All their situations come to get independency. Such hypotheiss, however, is unreal and all the imagos are sure to be relatively dependent. That distribution of the injured stems attacked by the rice stem borer which seems to have the dependent mechanism of distribution is surely wanting independency.

So, it may not be taken that the Poisson distribution type is suitable as a theoretical model for the distribution of the injured stems attacked by the rice stem borers, but the attempt of applying the Poisson distribution type to the actual distribution was unsuccessful as was expected. It's aspect is shown in the Table 2. All the cases of first, second, and third examinations show their widely different aspects through first generation period. The later the examination date is, the greater the divergence coefficient and its difference with the Poisson distribution type are. The aspect of actual frequency curve is slow in its both ends in comparison with the theoretical curve of the Poisson distribution and the frequency of the smaller and greater parts of class values is fairly dense,

Table 2. Goodness of fit for Poisson distribution.

Class	1st Examination		2nd Examination		3rd Examination	
	obs.	theor.	obs.	theor.	obs.	theor.
0	2635	2436	1874	1058	1328	598
1	905	1208	737	1407	732	1137
2	332	300	588	936	697	1080
3	105	50	387	415	509	684
4	16	4+	190	138	337	325
5	6	6	91	37	176	123
6	1		49	8	92	39
7			26	7+	54	11
8			24	1	24	2
9			14		15	9+
10			5		8	1
11			4		4	
12			4		7	
13			4		3	
14			3		2	
15					5	
16					1	
17					1	
18					1	
19						
20					1	
21					2	
22						
23						
24					1	
Total	4000	4000	4000	4000	4000	4000
μ'_1	0.496	0.496	1.329	1.329	1.906	1.906
μ_2	0.659		3.336		4.802	
Px^2	$\ll 0.001$		$\ll 0.001$		$\ll 0.001$	

it shows, according to Lexis' theory of distribution, the aspect of over dispersion.

The author already pointed out that the situations occupied by the imagos can not be independent each other. And as already reported, the imagos encroach the rice stem migrating and dispersing from one stem to another without staying still on one part even after they intrude into the rice stem. This fact seems to mean that the injury given to one stem of a certain plant promotes the percentage of the number of the injured stems for the hill. It is, therefore, not reasonable to expect a kind of contagious mechanism about the occurrence of the rice stem's injury. Iih[7] (1951) on the imago's distribution, and Kono[10] (1952) on the distribution of the number of the injred stems per hill, observed that both the two cases showed, setting aside the question of mechanical coincidence, a fundamental coincidence with the contagious distribution of the Polya-Eggenberger type.

The author also devised first the contagious mechanism of the Polya-Eggenberger for the mechanism of the distribution and occurrece of the injured stems attacked by the rice stem borer, before I tried to adopt for a statistical model of distribution, the Polya-Eggenberger contagious distribution type which was

Table 3. Gooduess of fit for P. E. distribation.

Class	1st Examination		2nd Examination		3rd Examination	
	obs.	theor.	obs.	theor.	obs.	theor.
0	2635	2605	1874	1779	1323	1255
1	905	973	737	943	732	949
2	332	302	583	533	697	646
3	105	87	387	308	509	422
4	16	24	190	180	337	271
5	6	5+	91	105	176	172
6	1	9	49	62	92	108
7			26	37	54	67
8			24	22	24	42
9			14	13	15	26
10			5	8	8	16
11			4	5	4	10
12			4	3	7	6
13			4	13+	3	4
14			3	2	2	2
15					5	1
16					1	16+
17					1	3
18					1	
19						
20					1	
21					2	
22						
23						
24					1	
Total	4000	4000	4000	4000	4000	4000
h		0.496		1.349		1 906
b		0.329		1.509		1.519
x^2	14.832		83.75		109.7	
px^2	$\fallingdotseq$ 0.005		$\ll$ 0.001		$\ll$ 0.001	

formed by unfastening and generalizing such severse conditions about independency as in the Poisson distribution type. But all the results acquired by the application of the Polya-Eggenberger distribution to the actual distribution showed, unexpectedly, no fair fitness all through first, second, and third examinations.

Table 4. Gooduess of fit for P. E. distribation (4-Hill unit)

Class	1st Examination		2nd Examination		3rd Examination	
	obs.	theor.	obs.	theor.	obs.	theor.
0	292	280	118	124.2	64	81.6
1	231	243	121	126.9	77	90.7
2	167	174	126	116.0	78	89.2
3	115	115	104	102.3	91	83.8
4	71	74	81	88.1	69	77.0
5	52	44	77	75.0	80	69.7
6	27	27	70	63.2	61	62.6
7	23	16	54	53.0	58	55.7
8	10	10	53	44.3	64	49.4
9	4		43	36.6	50	43.6
10	2		24	30.3	42	38.4
11	3 } 12	} 17	19	25.1	43	33.7
12	1		17	20.7	35	29.5
13	2		11	17.1	35	25.8
14			17	14.1	29	22.5
15			15	11.6	16	19.6
16			10	9.5	21	17.1
17			3	7.8	19	14.8
18			6	6.4	11	12.9
19			3	5.2	9	11.2
20			3	4.3	8	9.7
21			5	3.5	2	8.4
22			3	2.9	5	7.3
23			4	2.3	7	6.3
24			4	1.9	2	5.4
25			2	1.6	3	4.7
26			1	1.3	1	4.1
27			1	1.0	3	3.5
28					5	3.0
29				28+		2.6
30				3.8		2.3
31			4		2	1.9
32					2	1.7
33						1.4
34						
35			1		1	34+
36					2	9.9
37					1	
38						
39						
40					2	
41						
⋮						
53					1	
Total	1000	1000	1000	1000	1000	1000
	μ'_1=1.984 μ_2=4.542	h=1.984 d=1.289	μ'_1= 5.319 μ_2=27.709	h=5.319 d=4.209	μ'_1= 7.625 μ_2=52.299	h=7.625 d=5.858
x^2 px^2	7.58 ≒ 0.50		17.20 ≒ 0.50		35.60 ≒ 0.025	

(See the Table 3).

Thus, the fitting of the Polya-Eggenberger distribution to the frequency distribution of the number of the injured stems per hill was unsuccessful, while all in the two cases except third examination showed very good fitness to the theoretical frequency of the Polya-Eggenberger distribution acquired by extending the unit area to four hills. (See the Table 4)

It seems to suggest the necessity of adopting the unit area a little larger in such case of the comparatively great percentage of injury as in this research data. It is overhasty to regard the contagious type as a genetic mechanism of distribution only because of the apparent coincidence of the frequency distribution of the number of the injured stems to the theoretical model of the Polya-Eggenberger distribution. The apparent aspect of the Polya-Eggenberger distribution existing in the other genetic conditions must not be neglected. Regretfully, however, the author could not get any conclusion about the question becuase the storatification test about the compound Poisson distribution of the Γ type was difficult to examine in this reserach data.

Neyman showed, the statistical patern of distribution for such the contagious distribution types as should be apiled to the population distribution consisting of the imagos which hatch, migrate, and disperse from the stage of an egg-mass existing at place by chance.

Fundamentally, the contagious mechanism in the Neyman type is possibly fit for the distribution of the number of the injred stems attacked by the rice stem borers, as the details about the hypothesis and others composing the basis of the Neyman distribution shall be disscussed in another lecture books.

The results of the actual observation showed fair fitness with the Neyman's type A contagious distribution, two parameters, at first investigation but not in all the case after second investigation. (See the Table 5)

It is difficult to give a concrete examination about the reason why only the result of the observation in first investigation showed good agreement with the contagious distribution of the Neyman type and the results of the investigations after that showed bad agreement with it. The authoer can only suppose as followes :

Essentially, that elements which controle the distribution of the injured stems are fairly similar to some hypotheses composing the Neyman type distribution. They show good agreement with the Neyman type distribution holding the parameter of stable value in such early stage of injury as many conditions keep comparatively their uniformity. But gradually with the examination date becoming later the uniformity gets confused and the agreement accordingly become bad as a result of the convolution of the Neyman type distributions which have the parameters of different value.

The break-out of the insect in 1951 was unusually late and the highest of

Table 5. Goodness of fit for Neyman type A distribuation.

Class	1st Examination		2nd Examination		3rd Examination	
	obs.	theor.	obs.	theor.	obs.	theor.
0	2635	2628	1874	2014	1328	1501
1	905	937	737	592	732	630
2	332	320	588	534	697	606
3	105	88	387	365	509	458
4	16	20	190	220	337	311
5	6	5+	91	127	176	201
6	1	7	49	71	92	124
7			26	38	54	74
8			24	20	24	43
9			14	10	15	24
10			5	4	8	13
11			4	2	4	7
12			4	1	7	3
13			4		3	2
14			3	13+	2	14+
15				2	5	3
16					1	
17					1	
18					1	
19						
20					1	
21					2	
22						
23						
24					1	
Total	4000	4000	4000	4000	4000	4000
m_1		1.509		0.881		1.254
m_2		0.329		1.509		1.519
x^2	5.440		97.40		88.20	
px^2	$\fallingdotseq 0.25$		$\ll 0.001$		$\ll 0.001$	

break-out number of mothes was about in second 5 days of July. Therefore, the injury in the seedling period was supposedly very slight. (It is widely-known, in this connection, that the imagoes hatched in the seedling stage mostly become extinct without doing injury.) So, generally speaking, those injured stems which were found out at first examination, July 13th, had been attacked by the swarm of imagos hatched in the rice field after the transplanting from the nursery bed.

The transplanting into the rice field from seed bed was performed June 25th and first examination July 13th : there were only three weeks between them. So, concerning the necessary time to the hatching of imagos, the injured stems at first examination were supposedly encroached by the group of imagos which become the beginning of injury was common to all examinations, the parameter α, β, Γ showed almost very stable values all through the field, and presented good agreement with the theoretical model of the Neyman distribution type. And the form of the Neyman type distribution may also be regarded as that compound Poisson distribution of the Poisson type which is quite different in its genetic mechanism. But regretfully no examination could be given to it.

As to the causes why the aspect of observation value did not showed good agreement with the Neyman type distribution except first investigation, its solution is so difficult. If, however, the hypotheses in the bottom of the Neyman distribution type should be closely examined, some of the causes might possibly be cleared up.

As the time goes on, the imagos in their diverse conditions of growth at the field show a complex status of mixture and the group imagos of the individual egg-mass seemingly have fairly many differences in their growth degree, becuase the rice stem borers come flying one after another down to the rice field intermittantly during considerably a long time and lay their eggs. As to the distribution of the imagos themselves, acordingly, it is so unreasonable to give some fixed values to the parameter α, β, Γ, in all such rice field as mixed with aline elements. And so, as a matter of cause, the distribution of the injured stems in every examination period since second examination did not show the mere Neyman type distribution.

As the author have already discussed, the distribution type of the number of the injured stems per hill since second examination showed neither to the Neyman type nor the Polya-Eggenberger type. These frequency distribution types are similar rather to the Polya-Eggenberger distribution type, notwithstanding the fact that they showed no agreement with all the above-said distribution types. Their good fitness to the Polya-Eggenberger distribution in second and third examinations when the area was extended to four hills is very interesting subject to research. It will be colsely exanied in another chance.

IV. A discussion about the area-unit method

Regarding a distribution type, generally, the whole must equally be devided into some adequate blocks of fixed area unit, the occurrence number of phenomena every area unit must be examined, and all those unit areas which are equal in their occurrence number must be summed up, and after this its frequency distribution must be acquired.

As to this research-work, the average necessary area per hill was regarded as the standerd area unit in order to divide the whole. It means that the number of hills were adopted as the area unit, because the hills had been planted in regular order at the field. And here the equality of the areas, when the whole is devided into the equal unit area, is very important.

We can hardly think that all the hills always show one and the same condition of growth. Generally, some of them may be so thick as to bear a great number of stems and some may only show a comparatively poor growth. To devide the whole field by the individual hill unit is always followed with considerable uncertainity so far as the equality of the divided areas are concerned.

Considering together that the concrete living space of the rice stem borer is

within the rice stem, we may clearly understand it. Strictly speaking, such concrete living space should naturally be divided into equal part. As a matter of fact, however, it is undoubtedly a difficult way. So, that sort of uncertainty should be granted, so long as the adoption of the hill unit is not so abstructive practically. The following correlation coefficients were, out of the research data, acquired between the number of the whole stems and that of the injred stems. According to the coefficients, correlation can hardly be recognized between them.

1st examination $r = 0.1262$
2nd examination $r = -0.1203$ (Non-significance in 5% level)
3rd examination $r = 0.1530$

So, The author take it for granted that the slight difference of the numbers of tiller may possibly be neglected for the distribution of the injured stems, and the division method of the hill unit may be out of the question from the practical point of view as far as the researh data is conserned.

Although Koono and others[10] could not admit its significant difference, they recognized, conserning the distribution of the imagos in the second generation period, the fact that the number of the imagos is on the average in proportion to the number of the stems per hill. The division by the hill unit, acordingly, can not always be available and its application must be decided after carful consideration as it happened. In the proportion of the divided area adopted as its area unit, according to the dividing method, the original group has all the same quality and fixed distribution function in case of a certain unit area, while the group is not always equal in its quality and does not show always that fixed function in case of a different unit area.

The same aspect is, as have been previously mentioned, recognized in these research data. This is the greatest defect in the unit area method. The unit adopted in the observation is usually noted down against consequent confusion. The subject of the change of the distribution type after the renewal of unit area is partly refered in the following section, its details shall be disscussed some other time.

V. On the uniformity in the distribution field

The field of statistics must be first drawn into ecological field for the population of species when the statistical analysis is given to the quantitative structure of the population distribution. Uniformity must be kept in the field where things happen before a statistical model is given. (Toriih[13] 1952)

When a rice field of considerable area is used for the object of the examination, differ from the case inside the laboratory where various kinds of condition may be artificially adjusted to same degree in order that they may keep themselves uniform as possible, the examination about the uniformity of the distribution field above all is indispensable.

As to the uniformity of the distribution field, both the homogenity of the insects themselves and the uniformity of growth of the hills must biologically be examined from various point of view. Regretfully it could not be completely examined, because these reseach data do hardly include such results as become a clue to these examinations.

Arranging sistematically, however, the proportion of unit area to make it gradually larger than the one hill unit at the first observation, the variance was successively greater and consequently its coefficient of dispersion increased. The fact seems to show the situations within the distribution field are not uniform. Such difference, supposedly, came from the unstanderdization of the insects themselves. (See the Table 6)

Table 6. Increase of variance coefficient acompany with change of unit area.

	Item	Size of unit area			
		1 hill unit	4 hills unit	9 hills unite	16 hill unit
1st Examination	mean	0.496	1.984	4.503	7.936
	Variance	0.659	4.542	15.853	32.668
	$v/\bar{x}$	1.329	2.289	3.520	4.116
2nd Examination	mean	1.329	5.319	12.027	21.236
	Variance	3.336	27.709	90.209	217.159
	$v/\bar{x}$	2.509	5.209	7.491	10.226
3rd Examination	mean	1.906	7.625	17.326	30.500
	Variance	4.802	52.299	201.446	425.542
	$v/\bar{x}$	2.519	6.858	11.568	13.925

As a matter of cause, the inuniform nature at the whole field should not be decided merely by the internal difference, because the whole distribution field can be regarded as of the same quality in case of the general agreement of a distribution function, even if it showed an internally different nature.

VI. Postcript

What the author have discussed above in this report is only about the frequency distribution of the number of the injured stems per hill. These research data here, however, present a munber of other data to be further analysed and examined from the stand point of a distribution theory, many questions are not yet examined ; for example, the spatial structure of distribution was not refered, because the spatial situation which each the nuit area occupied was never taken into consideration when the frequency distribution under the unit area method. And the renewal of a distribution type in proportion to the measurement of unit area is also an interesting subject.

These questions shall be reported some other time after a more careful examination.

Summary

1. Analy is and considerations were given to the nature of the distribution of the injured stems attacked by the rice stem borer during the period of the first generation of the insect.

2. In the case of the individual plant unit, by taking up three theoretical patterns, namely, Poisson distribution, Polya-Eggenberger distribution and Neyman distribution type A, their fitness to the actual frequency distributions of the numbers of the injured stems were examined.

3. The frequency distribution of the number of injured stems per plant in the early stage of injury was good agreement with theoretical values of Neyman distribution type A, but in the case of later stage of injury, it corresponded neither to Neyman distribution type A nor to Polya-Eggenerger distribution. It showed, however, a type of distribution relatively similar to Polya-Eggenberger distribution.

4. With the increase of the unit area to four hills, the actual frequency distribution of the injured stems at any stage of injury through the period of the first generation of the insect showed fair fitness with theoretical values of Polya-Eggenberger distribution better than any other type of distribution.

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Studies on the Growth Habits of Rice Plant Varieties*

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(Received March 1, 1954)

I. Introduction

There are wide variations of growth habits found with the rice plant varieties now cultivated, but they are, as is well-known, roughly grouped into three types, *i. e.*, many-panicle type, heavy-panicle type and medium type.

Fuke[1] (1944) pointed out that there is a very close correlationship between those types and the geographical distributions or historical alterations of the varieties. Subsequently, Matsuo[2] (1948) distinguished, as a result of his research with 842 rice plant varieties now cultivated in different parts of the world into those 24 items of characteristics in external forms which were considered to have a specially close connection with the productive power of the rice plant, 39 types based on the likenesses they have in those characteristics. He then reduced them and showed that the rice plant varieties cultivated in the world could be grouped into 3 large types of A, B and C, stating in the same way as the above-mentioned Fuke that the type is an ecological characteristic which regulates the distribution of a variety.

The problem of growth habits is very important in choosing the adequate variety and in raising an ideal variety in a place. A morphological and physioecological investigations on the peculiarity of each type in reaction upon environment is for that reason considered to be an urgent necessity.

The past contributions on this problem, however, are not many in number. The principal works are only the studies by the above-mentioned Fuke[1] (1944) and Matsuo[2] (1948) chiefly in the ecological field, though there are partial and fundamental studies made by Baba[3] (1945) from a physiological point of view, by Fuke[4] (1950) on the hereditary construction of the growth habit and by

* Combined report of the 76th and 93rd reports of the Institute for Agricultural Research, Tohoku University (1953).

Moritani[5] (1950) on the method of classifying ecological types. Thus it follows that the solution of growth habit problems depends much upon the future explorations.

In consideration of the importance of clearly understanding the peculiarities of the growth habits in reaction upon environment from the above-cited reasons, the present authors have been pursuing a series of fundamental studies from various points of view in order to analyse them. The following is a summarized report of the result of an experiment conducted in 1951 on the peculiarities of the effects produced by restricting tillers on the form and quality of the rice plant according to different types of growth habts and the result of another experiment conducted in 1952 on the effects produced by the nipping of tillers for different densities of cultivation upon the form and quality of the rice plant. Not that the studies have made their full progress, but that the results reached so far may be of some interest to the readers.

An acknowledgement is due to Prof. Kengo Yamamoto and Prof. Masayuki Sakamoto of the Institute for many pieces of valuable adivce in conducting these studies.

II. Experiment 1. Effects of the restriction of sprouts upon the characteristics of rice plant

1. Material and methods.

Two varieties, Taihei-Mochi and Toyokuni, were used as experimental material. They are respectively one of the typical varities in Northern Honshu, the former of many-panicle type and the latter of heavy-panicle type. A care was taken to choose varieties which head approximately at the same period in the average year in order to bring about as little disturbance as possible in the results due to the difference of their heading periods. Rice seedlings were grown in nursery beds, and selections were made of those which were of the greatest possible uniformity. They were transplanted on June 6 into square concrete boxes, each 2×2 ft. (1/9 *tsubo*). Each box had 9 seedlings planted singly with spacing 6.6 *sun** ×6.6 *sun* between one another (81 seedlings per *tsubo*). The basic fertilizers for each vessel were 21 g of ammonium sulphate, 10 g of calcuim supersulphate and 6 g of potassium chloride, and no additional fertilizers were used because they were liable to disturb the growing process. Weeding was done three times and other items of management were performed according to the established method.

Five sections were made for examination according to the different numbers of sprout let to grow from one plant, namely 1–sprout section, 5–sprout section, 10–sprout section, 15–sprout section and free section. In 1–sprout section, all

* *Sun* is approximately equal to 0.1 ft.

the tillers were nipped, leaving the main stem alone, as soon as they made appearance ; and in 5–, 10–, and 15–sprout sections respectively, the tillers which appeared after the earlier ones together with the main stem had reached the intended number were nipped at the base as soon as they made appearance. The first nipping date of each section is as follows : 1–sprout section, June 25th ; 5–sprout section, July 3rd ; 10–sprout section, July 5th ; and 15–sprout section, July 10th. An investigation was made on the growing process and the products with a total of 30 boxes of 2 varieties and 5 sections made into 3 series and arranged according to the random raising method as shown in Figure 1. The numbers as appear in the results of investigation in this paper are the averrage numbers of the 27 plants in 3 vessels belonging to each section. However, some plants were excluded which had suffered from special disturbances during the experiment.

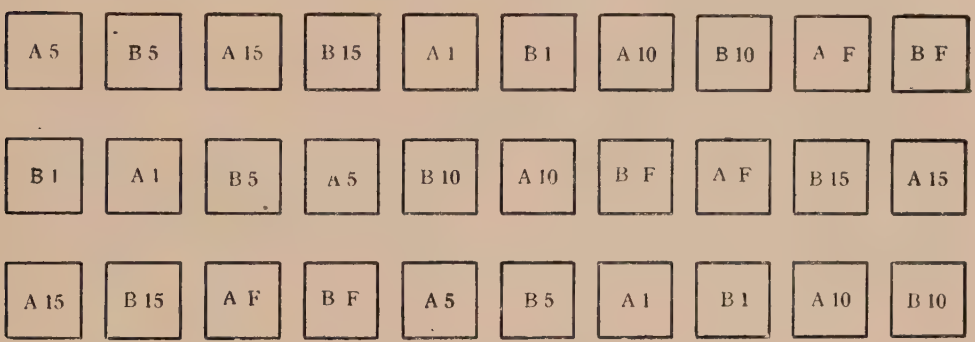

Figure 1. Arrangement of experimental sections.

Remarks : 1. The letter A stands for Taihei-Mochi, and B for Toyokuni.
2. The Arabic numerals show the kinds of experimental sections, or the numbers of sprouts.
3. The letter F stands for free section or control.

2. Result of investigation on growing process.

An investigation was made every five days as to the number of main stem leaves and the plant height as well as the heading date of each sprout from the First Investigation Date fixed for June 20th, 15 days after transplantation (immediately after rooting), till the XIII Investigation Date on August 19th. The investigation, however, of the main stem leaves was discontinued on the XII Investigation Date (August 14th), on which the last leaf on main stem of each plant appeared already with each variety and each experimental section.

(i) The number of main stem leaves.

The result of the investigation with the number of main stem leaves is shown in Table 1. It is natural that on the First Investigation Date (June 20th), which was immediately following the rooting and prior to the restricting of the number of stems, there was hardly any difference between the experimental sections, showing an approximate equilibrium held among all the materials.

Table 1. Progress in the number of main stem leaves.

Date of investigation			Free section		15-sprout section		10-sprout section		5-sprout section		1-sprout section	
			A	B	A	B	A	B	A	B	A	B
I	June	20	7.6	8.2	7.6	8.2	7.5	8.1	7.5	8.1	7.4	8.1
II		25	8.5	9.0	8.8	8.9	8.8	8.8	8.6	9.3	8.6	9.3
III		30	9.9	10.1	9.9	10.1	9.8	10.3	9.8	10.4	9.9	10.4
IV	July	5	10.9	10.8	10.9	10.9	10.9	10.9	10.8	11.4	11.4	11.5
V		10	11.8	12.0	11.8	12.1	11.8	12.1	11.8	12.3	12.2	12.5
VI		15	12.6	12.7	12.7	12.8	12.7	12.8	12.7	13.1	13.2	13.5
VII		20	13.3	13.2	13.5	13.4	13.5	13.4	13.9	13.8	14.5	14.7
VIII		25	14.0	13.8	14.2	14.0	14.4	14.2	14.6	14.7	15.6	15.8
IX		30	14.9	14.6	15.0	14.8	15.2	15.1	15.6	15.7	17.1	16.9
X	Aug.	4	15.3	14.8	15.5	15.4	15.8	15.6	16.1	16.1	17.8	17.4
XI		9	16.1	16.0	16.3	16.3	16.6	16.3	16.9	17.0	18.4	18.3
XII		14	16.2	16.3	16.5	16.4	16.8	16.5	17.2	17.1	19.0	18.6

Remarks : The letters A and B stand for Taihei-Mochi and Toyokuni respectively, as in the following tables.

Approximately from the IV Investigation Date (July 5th) on, a greater increase was noticed in the number of leaves in sections of fewer sprouts than in Free Sections. As is shown in Table 2, the more sprouts there remained in a section, the later was the increase in the number of leaves in it as compared with a Free Section, and the smaller was the final increase. There was a tendency that

Table 2. Increase in the number of main stem leaves as compared with those in Free Section.

Date of investigation			Varieties	15 sprout section	10 sprout section	5-spout section	1-sprout section
I	June	20	Taihei-Mochi	0	−0.1	−0.1	−0.2
			Toyokuni	0	−0.1	−0.1	−0.1
V	July	10	Taihei-Mochi	0	0	0	0.4
			Toyokuni	0.1	0.1	0.3	0.5
VII		20	Taihei-Mochi	0.2	0.2	0.6	1.2
			Toyokuni	0.2	0.2	0.6	1.5
IX		30	Taihei-Mochi	0.1	0.3	0.7	2.2
			Toyokuni	0.2	0.5	1.1	2.3
XI	Aug.	9	Taihei-Mochi	0.2	0.5	0.8	2.3
			Toyokuni	0.3	0.3	1.0	2.3
XII		14	Taihei-Mochi	0.3	0.6	1.0	2.8
			Toyokuni	0.1	0.2	0.8	2.3

the increase in number of leaves was greater with the many-panicle type, Taihei-Mochi, than with the heavy-panicle type, Toyokuni. There was, however, no distinctive difference recognized in the progress of increase between the two varieties in the course of growth. These tendencies are illustrated in Figures 2 and 3.

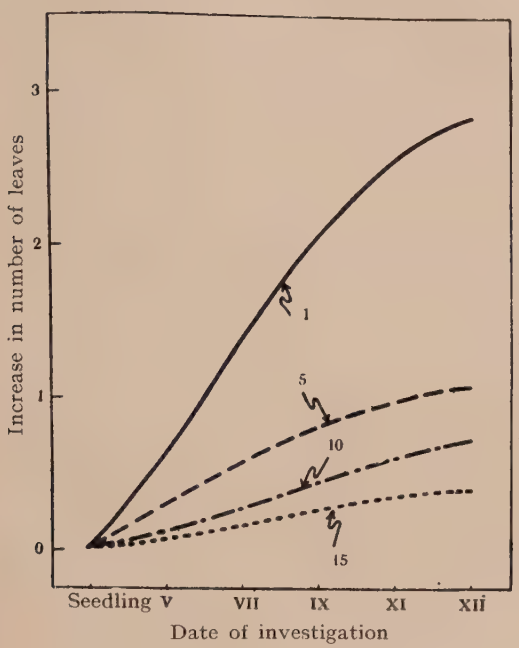

Figure 2. Increase in the number of main stem leaves as cainpared with those in Free Section (Taihei-Mochi).

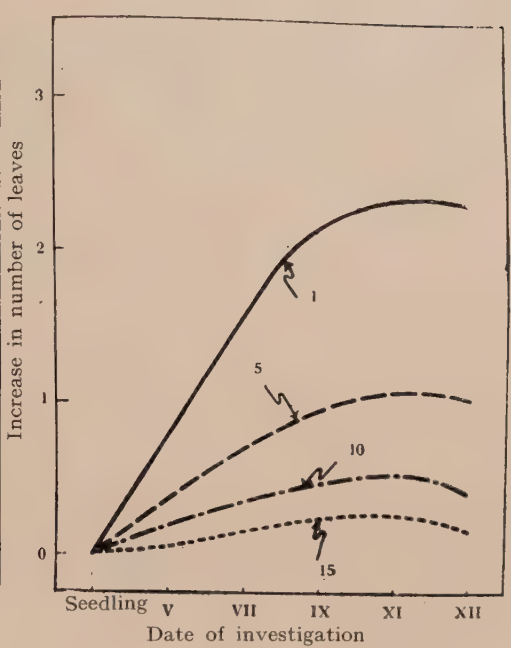

Figure 3. Increase in the number of main stem leaves as compared with those in Free Section (Toyokuni).

(ii) Plant height.

The measurement of plant height in the process of growth was taken with the longest sprout to its tip, and the result is shown in Table 3. In the period immediately prior to heading, the rapid elongation of peduncles made the sprouts also taller suddenly. (In sections of the earliest heading date in the present

Table 3. Process of plant height.

Date of investigation			Free section		15-sprout section		10-sprout section		5-sprout section		1-sprout section	
			A	B	A	B	A	B	A	B	A	B
			cm	cm	cm	cm	cm	cm	cm	cm	cm	cm
I	June	20	27.9	36.5	27.8	35.6	28.2	36.0	27.4	36.2	27.8	35.1
II		25	30.5	39.8	31.8	38.6	30.8	39.6	29.5	39.3	30.9	38.8
III		30	32.4	41.4	33.1	40.6	32.2	42.1	32.1	41.3	34.6	41.6
IV	July	5	36.4	46.1	36.9	44.3	36.4	45.9	36.8	44.9	39.8	48.1
V		10	41.4	50.9	41.5	50.1	41.8	51.6	42.1	51.5	45.9	55.3
VI		15	45.8	57.9	47.6	57.8	46.1	58.9	48.5	56·7	52.5	63.3
VII		20	51.3	66.3	53.8	64.1	53.2	67.8	56.1	67.1	58.5	72.3
VIII		25	58.2	72.0	58.5	71.6	61.0	74.0	64.1	74.8	63.4	77.9
IX		30	67.9	79.7	67.9	75.4	71.8	82.5	73.4	82.2	69.9	83.6
X	Aug.	4	76.7	86.7	78.2	85.5	80.6	85.2	84.0	88.1	76.6	86.7
XI		9	83.8	97.3	84.3	91.8	85.9	95.7	91.3	93.6	85.7	90.2
XII		14	89.0	100.8	91.2	95.7	90.6	102.1	94.5	96.5	91.8	93.1
XIII		19	102.0	103.8	102.4	105.0	103.3	109.0	103.0	105.2	96.1	100.1

experiment, the first heading was seen of Toyokuni on August 12th, and of Taihei-Mochi on August 14th.) The variations of the plant height in each section as compared with that in the Free Section, all measured before the great effects of the rapid internodal lengthening were manifested, are shown in Table 4. Namely, an increase was seen in 1–sprout section after the II-III Investigation Dates

Table 4. Variations of the plant height as compared with that in Free Section.

Date of investigation	Varieties	15–sprout section	10 sprout section	5–sprout section	1–sprout section
		cm	cm	cm	cm
I June 20	Taihei-Mochi	−0.1	0.3	−0.5	−0.1
	Toyokuni	−0.9	−0.5	−0.3	−1.4
III 30	Taihei-Mochi	0.7	−0.2	−0.3	2.2
	Toyokuni	−0.8	0.7	−0.1	0.2
V July 10	Taihei-Machi	0.5	−0.1	0.4	3.4
	Toyokuni	−1.8	−0.2	−1.2	2.0
VII 20	Taihei-Mochi	2.7	1.9	4.8	7.2
	Toyokuni	−2.2	1.5	0.8	6.0
IX 30	Taihei-Mochi	0	3.9	5.5	2.0
	Toyokuni	−4.3	2.8	2.5	3.9
XI Aug. 9	Taihei-Mochi	0.5	2.1	7.5	1.9
	Toyokuni	−5.5	−1.6	−3.7	−7.2

(June 25th – 30th); and subsequently, there was a tendency that an increase began to be seen in 5–sprout sections, 10–sprout sections and 15–sprout sections, successively. However, later on, as the heading date drew nearer, the increase in plant height tended to get smaller as compared with that in Free Section. This tendency of lowering increase, which was not remarkable with Taihei-Mochi, was so marked that its height in every one of the non-free experimental sections became lower than that in Free Section on the XI Investigation Date. Further, it should be added that the observation of the testing farm revealed that in 1–plant section the sprouts were big and the leaves were specially thick with a deep green, looking somewhat shrunk and a little deformed.

Table 5. Average heading date of each sprout.

	Varieties	Free section	15–sprout section	10–sprout section	5–sprout section	1 sprout section
Average heading date in August	Taihei-Mochi	17.6	16.4	16.0	15.4	15.0
	Toyokuni	15.2	14.6	13.7	13.6	13.5
Days cut from those in Free section	Taihei-Mochi	—	0.2	0.4	0.7	1.7
	Toyokuni	—	0	0.6	0.6	1.4

Note: The number of days cut from those in Free Section in this table and the increments in Tables 6-12 are computed by the comparison with the tillers at the same nodular position in Free Section.

(iii) Heading date.

The average heading date based on the measurement of each sprout is given in Table 5. The average heading date in each of the sections of restricted sprout number hastened as compared with that of the tiller at the same nodal position in Free Section, and a tendency was noticed that the hastening was greater in sections of fewer sprouts. This tendency was seen with both varieties. It was also noticed that the hastening due to the restriction of sprout number seemed to be greater with Taihei-Mochi than with Toyokuni.

3. Result of investigation with the harvested plant.

(i) Stem length.

Stem lenghth (ear length exclusive) and the length of parts forming the stem, namely the peduncle, *i.e.*, the internode directly below the ear, and the part lower than the peduncle (the length of which will be tentatively called "basic stem length" in the following parts) are shown in Table 6.

Table 6. Avergae stem length in each sprout.

	Stem length & its parts	Varie-ties	Free section	15-sprout section	10-sprout section	5 sprout section	1-sprout section
			cm	cm	cm	cm	cm
Actual measurements	Stem length	A	66.9	74.9	76.4	77.4	70.8
		B	71.6	79.5	80.3	81.7	73.5
	Peduncle length	A	35.5	37.5	38.9	42.0	38.4
		B	34.2	37.5	38.2	40.6	38.9
	Basic stem length	A	31.4	37.4	37.9	35.4	32.4
		B	37.4	42.0	42.1	41.1	34.6
Increase in restricted sections *vs.* Free section	Stem length	A	—	1.9	2.1	2.3	−7.1
		B	—	1.1	1.3	1.7	−8.7
	Peduncle length	A	—	3.8	5.0	7.3	3.1
		B	—	2.4	2.7	5.2	2.2
	Basic stem length	A	—	−1.9	−2.9	−5.0	−10.2
		B	—	−1.3	−2.7	−3.5	−11.0

Stem length in every one of the restricted sections except 1-sprout section was increased by the restriction of sprout number, the increments being greater in the order from 15-sprout section to 5-sprout section; while in 1-sprout section a decrease was seen with both varieties as compared with Free Section. To measure separately the above-described two parts of the stem, peduncle length showed an increase which was greater in the order from 15-sprout section to 5-sprout section, and its increase in one-sprout section was only a little smaller. Basic stem length, however, showed a considerable decrease in every experimental sections from 15-sprout section to 5-sprout section, and the severer was the restriction of sprout number, the greater was the decrease, which was such an opposite tendency to what was seen in the case of peduncle length that in 1-sprout section the decrease was as much as 10 cm. However, there was no great

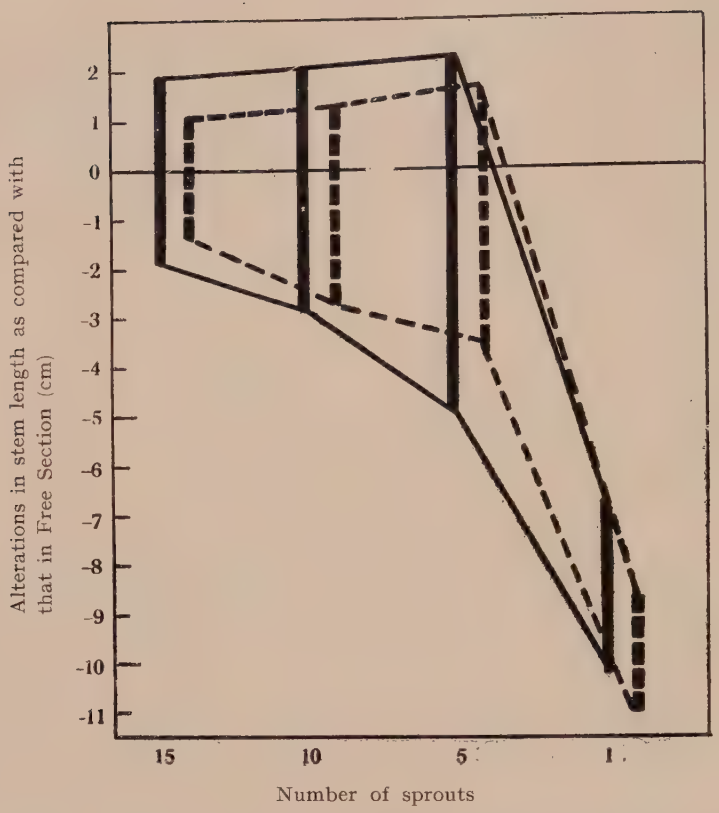

Figure 4. Increment of the stem length in each sprout as compared with that of the tiller at the same position in Free Section.

difference between the two varieties. These tendencies are illustrated in Figure 4, and Taihei-Mochi is shown by solid line, and Toyokuni by dotted line. Both lines indicate the values of alterations as compared with those in Free Section. Both the upper curves denote the alterations in stem length, and both the lower curves, the alterations in basic stem length ; the perpendicular lines connecting the upper and lower lines, therefore, denote the alterations in peduncle length.

(ii) Ear length and number of ear branches.

The average ear length is given in Table 7. Ear length was increased in proportion as the restriction of sprout number got severer or the sprout number got smaller, and there was no special difference recognized in increasing tendency between the two varieties.

As is shown in Table 8, the number of ear branches increased likewise in inverse proportion to the number of sprouts, and there was a tendency that the increase was a little greater with Toyokuni than with Taihei-Mochi.

Table 7. Average ear length.

	Varieties	Free section	15-sprout section	10-sprout section	5-sprout section	1-sprout section
		cm	cm	cm	cm	cm
Average ear length	Taihei-Mochi	19.9	22.3	23.0	24.8	25.6
	Toyokuni	17.6	19.6	20.7	22.0	23.8
Increase in restricted *vs.* Free section	Taihei-Mochi	—	1.2	1.5	2.6	2.8
	Toyokuni	—	0.6	1.3	2.2	4.0

Table 8. Average number of ear branches.

	Varieties	Free section	15-sprout section	10-sprout section	5-sprout section	1-sprout section
Average number of ear branches	Taihei-Mochi	7.5	9.2	9.9	11.0	12.0
	Toyokuni	9.6	11.6	12.4	13.6	16.1
Increase in restricted *vs.* Free section	Taihei-Mochi	—	0.4	0.8	1.4	1.9
	Toyokuni	—	0.7	1.0	1.6	3.2

(iii) Ear weight and number of grains per ear.

The average ear weight and number of grains per ear are shown in Tables 9 and 10, respectively. Both varieties showed a remarkable increase in inverse proportion to the decrease in sprout number, and there was no special difference in that tendency between the two.

Table 9. Average ear weight.

	Varieties	Free section	15-sprout section	10-sprout section	5-sprout section	1-sprout section
		g	g	g	g	g
Average ear weight	Taihei-Mochi	1.2	2.4	2.9	3.5	3.6
	Toyokuni	1.8	2.6	3.0	4.3	4.4
Increase in restricted *vs.* Free section	Taihei-Mochi	—	0.8	1.3	1.8	1.9
	Toyokuni	—	0.4	0.7	1.8	1.9

Table 10. Average number of grains per ear.

	Verieties	Free section	15-sprout section	10-sprout section	5-sprout section	1-sprout section
Average number of grains per ear	Taihei-Mochi	76.2	112.6	139.4	151.0	191.4
	Toyokuni	97.5	122.5	155.5	184.0	219.4
Increase in restricted *vs.* Free section	Taihei-Mochi	—	17.8	41.4	45.9	88.2
	Toyokuni	—	8.7	39.7	57.3	88.1

(iv) Percentage of fertile grains and weight of 100 grains.

There was a tendency, as shown in Table 11, that the percentage of fertile

grains increased in inverse proportion to the decrease in sprout number, and in which the percentage was a little higher with Taihei-Mochi than with Toyokuni.

Table 11. Percentage of fertile grains.

	Verieties	Free section	15 sprout section	10-sprout section	5 sprout section	1 sprout section
Percentage of fertile grains	Taihei-Mochi	80.9%	85.5%	90.7%	91.8%	92.8%
	Toyokuni	84.7	89.4	89.8	90.2	91.2
Increase in restricted *vs.* Free section	Taihei-Mochi	—	5.0	9.8	10.2	10.3
	Toyokuni	—	2.3	1.7	2.3	3.2

Hulled rice grains were picked up at random from each experimental section to form 15 groups each containing 50 grains, and each group was weighed. The result is given in Table 12. It shows that though there was a slight tendency that the restriction of sprout number caused a little increase in grain weight in the case of Taihei-Mochi, the increasing tendency was not marked if the result of Toyokuni was taken together into consideration.

Table 12. Weight of 50 hulled grains.

	Varieties	Free section	15-sprout section	10-sprout section	5-sprout section	1 sprout section
Weight of 50 grains	Taihei-Mochi	0.94g	0.99g	0.97g	1.01g	0.94g
	Toyokuni	1.09	1.06	1.09	1.10	1.10
Increase in restricted *vs.* Free section	Taihei-Mochi	—	0.05	0.03	0.07	0
	Toyokuni	—	−0.03	0	0.01	0.01

III. Experiment 2. Effects of the nipping of tillers upon the characteristics of rice plant

1. Material and methods.

As in Experiment 1, two varieties, Taihei-Mochi and Toyokuni were used as experimental material. The seeds were sown in a rice seedling bed on April 23rd, and seedlings of the greatest possible uniformity (43 days old ; the average number of main stem leaves being 6.7 with Taihei-Mochi, and 6.6 with Toyokuni ; the average seedling length being 18.1 cm with Taihei-Mochi and 25.0 cm with Toyokuni) were selected on June 6th to be transplanted singly into square concrete boxes, each 2 by 2 ft. (1/9 *tsubo*), furnishing five sections according to the spacings 1.0 *sun*, 1.5 *sun*, 2.0 *sun*, 4.0 *sun* and 6.6 *sun* square, respectively. Incidentally, the converted number per *tsubo* of the transplanted seedlings in each section was as follows : 1.0 *sun* section, 3,600 ; 1.5 *sun* section, 1,600 ; 2.0 *sun* section, 900 ;

4.0 *sun* section, 225 ; and 6.6 *sun* section, 81. The basic fertilizers for each box were 21 g of ammonium sulphate, 10 g of calcium supersulphate and 6 g of potassium chloride. An additional fertilizer of 3 g of ammonium sulphate solved in water was given to each box on June 3rd. Other items of management were done according to the established method.

The experimental sections totaled 6, including the above-mentioned 5, distinguished by cultural density as 1.0 *sun*, 1.5 *sun*, 2.0 *sun*, 4.0 *sun* and 6.6 *sun* sections, and a free section with a spacing of 6.6 *sun* added as a control. The objects of examination were the 9 plants in the middle of each box.

In each section except Free Section (Control), all the tillers were nipped at their base as soon as they made appearance, leaving only the main stem. Nipping was begun on June 23rd when the first tiller appeared in every section. An investigation was made on the growing process and the products with a total of 36 boxes of 2 varieties and 6 secctions made into 3 series and aranged according to the random raising method as is shown in Figure 5. The figures given as the results of investigations in this paper are, if not otherwise mentioned, the average numbers of the 27 plants in 3 boxes belonging to the same kind of section.

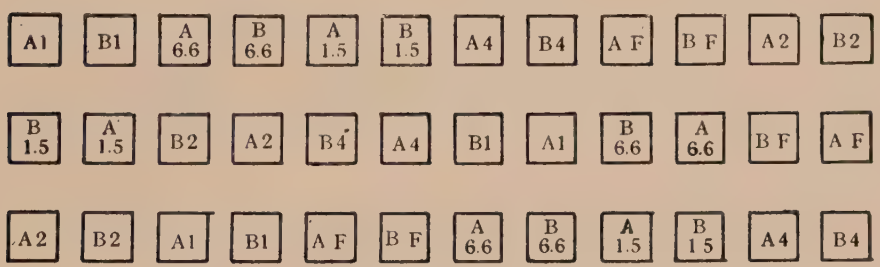

Figure 5. Arrangement of experimental sections.

Remarks : 1. The letter A stands for Taihei-Mochi, and B for Toyokuni.
2. The Arabic numerals show the kinds of experimental sections, or the spacing in *sun*.
3. The letter F stands for free section or control.

2. Result of investigation on plant growing process.

An investigation was made every seven days on the number of main stem leaves and the plant height as well as the heading date of each plant (which was made up of only the main stem) from the First Investigation Date fixed for June 16th, 10 days after transplantation (immediately after rooting), till the X Investigation Date on August 18th.

(i) The number of main stem leaves.

The result of the investigation on the number of main stem leaves is shown in Table 1. On the First Investigation Date (June 16th), which was

immediately following the rooting, there was hardly any difference between the experimental sections, showing an approximate equilibrium held among all the materials. Differences began to be recognized around the III Investigation Date (June 30th) between different sections : the more sparcely a section was planted, the greater was the number of leaves in it ; and to compare the stems of each arranged section with the main stems of the Free Section, closely-planted sections (1.0 *sun* section and 1.5–*sun* section) showed a smaller increase than the main stems of the Free Section and sparcely-planted sections showed a greater increase. As is shown in Table 14, moreover, the more closely a section was planted, the later was the appearance of leaves at the corresponding nodal position with the Free Sections, the nodal position of the last leaves being lower, and consequently the

Table 13. Progress in the number of main stem leaves.

Date of investigation	Free section		1.0–*sun* section		1.5 *sun* section		2.0–*sun* section		4.0–*sun* section		6.6–*sun* section	
	A	B	A	B	A	B	A	B	A	B	A	B
I June 16	8.6	8.9	8.3	8.5	8.7	8.7	8.8	8.8	8.8	8.8	8.8	8.8
II 23	10.1	10.5	9.2	9.5	9.7	9.7	9.9	10.0	10.2	10.2	10.3	10.4
III 30	11.4	11.9	10.2	10.2	10.7	10.8	10.9	10.9	11.4	11.4	11.5	11.8
IV July 7	13.0	13.4	11.0	11.2	11.9	11.9	12.2	12.1	12.9	12.9	13.3	13.3
V 14	14.0	14.3	11.7	11.7	12.5	12.5	12.9	12.9	14.2	14.1	14.5	14.3
VI 21	15.0	15.2	12.3	12.7	13.3	13.5	13.9	13.7	15.3	15.1	15.7	15.7
VII 28	15.8	16.2	13.1	13.2	14.2	14.2	14.8	14.6	16.4	16.1	16.7	16.7
VIII Aug. 4	16.8	17.0	13.8	14.1	15.1	15.0	15.6	15.9	17.5	16.9	18.0	17.8
IX 11	17.5	17.5	14.5	14.3	15.6	15.2	16.5	15.8	18.7	17.8	19.1	18.6
X 18	17.6	17.5	14.8	14.3	15.7	15.2	16.7	15.8	18.7	17.8	19.8	18.9

Table 14. Increase in number of the main stem leaves as compared with those in Free Section.

Date of investigation	Varieties	1.0–*sun* section	1.5 *sun* section	2.0–*sun* section	4.0–*sun* section	6.6 *sun* section
II June 23	Taihei-Mochi	−0.9	−0.4	−0.2	0.1	0.2
	Toyokuni	−1.0	−0.8	−0.5	−0.5	−0.1
IV July 7	Taihei-Mochi	−2.0	−1.1	−0.8	−0.1	0.3
	Toyokuni	−2.2	−1.5	−1.3	−0.5	−0.1
VI 21	Taihei-Mochi	−2.9	−1.7	−1.1	0.3	0.7
	Toyokuni	−2.5	−1.8	−1.5	−0.1	0.5
VIII Aug. 4	Taihei-Mochi	−3.0	−1.8	−1.2	0.7	1.2
	Toyokuni	−2.9	−2.0	−1.6	−0.1	0.8
X 18	Taihei-Mochi	−2.8	−1.9	−0.9	1.1	2.2
	Toyokuni	−3.2	−2.3	−1.7	0.3	1.4

number of leaves was smaller. The tendency was that the increase in the number of leaves in sparcely-planted sections both in the process of growth and at the end was greater with the many-panicle type, Taihei-Mochi, than with the heavy-panicle type, Toyokuni. There was also a tendency that the decrease in the

number of leaves in closely-planted sections was smaller with Taihei-Mochi. These tendencies are illustrated in Figures 6 and 7.

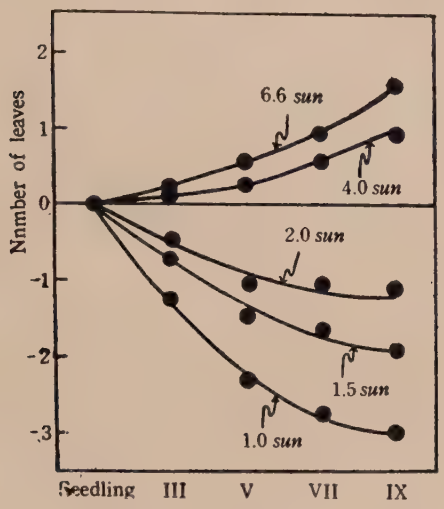

Figure 6. Alterations in the number of leaves as compared with those in Free Section (Taihei-Mochi).

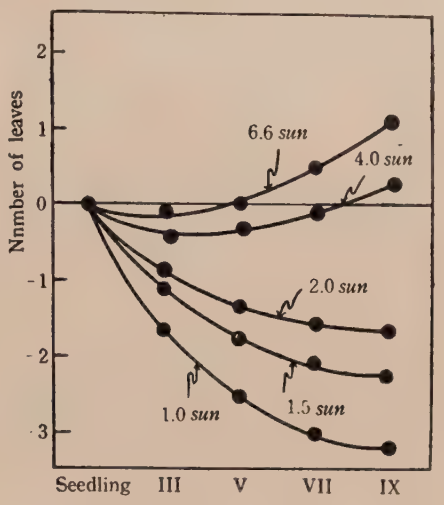

Figure 7. Alterations in the number of leaves as compared with those in Free Section (Toyokuni).

(ii) Plant height.

The measurement of plant height in growing process was taken with the longest blade to its tip, and the results and the percentage of increase in height at each investigation date in the process of growth are shown in Tables 15 and 16. The average percentage of increase in height at all the investigation dates, the percentage of the average increase rate of Toyokuni to that of Taihei-Mochi,

Table 15. Growing process of plant height.

Date of investigation			Free section		1.0–*sun* section		1.5–*sun* section		2.0–*sun* section		4.0–*sun* section		6.6–*sun* section	
			A	B	A	B	A	B	A	B	A	B	A	B
			cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm
I	June	16	20.4	29.0	21.1	27.1	20.5	27.6	20.7	28.3	20.8	29.1	20.1	28.7
II		23	27.7	39.8	24.3	31.7	24.8	32.8	25.8	33.7	29.6	38.0	29.7	39.7
III		30	32.7	45.6	28.8	35.3	27.7	36.6	29.4	37.1	32.7	47.9	34.2	47.4
IV	July	7	40.0	50.2	40.4	48.8	40.5	50.1	42.5	50.7	44.4	55.2	43.1	56.8
V		14	47.4	58.3	48.3	58.5	47.7	58.6	47.4	59.4	51.0	63.1	51.9	65.4
VI		21	59.6	68.8	58.0	66.1	55.5	68.1	59.2	65.5	62.2	68.4	62.6	82.4
VII		28	67.9	77.8	68.3	77.5	64.6	80.2	70.0	72.5	71.5	87.1	70.8	89.5
VIII	Aug.	4	79.6	83.7	75.3	80.5	72.7	85.8	75.0	85.7	77.2	89.3	77.1	92.0
IX		11	89.8	93.8	80.3	84.9	83.8	88.9	83.8	91.7	89.5	95.3	90.2	98.7
X		18	100.9	105.1	85.5	93.3	92.3	98.9	93.0	102.8	96.0	103.1	96.5	105.4

Table 16. Rate of increase in plant height at each investigation date.

Date of investigation			Free section		1.0-*sun* section		1.5-*sun* section		2.0-*sun* section		4.0-*sun* section		6.6-*sun* section	
			A	B	A	B	A	B	A	B	A	B	A	B
			%	%	%	%	%	%	%	%	%	%	%	%
I	June	16	12.7	16.0	16.6	8.0	13.3	10.4	14.9	13.2	19.4	16.4	11.1	14.8
II		23	30.9	37.2	15.2	17.0	21.0	18.8	24.6	19.1	34.8	30.6	47.8	38.3
III		30	18.1	14.6	18.5	11.4	11.7	9.8	14.0	10.1	10.5	26.1	15.2	19.4
IV	July	7	22.3	10.1	40.3	38.3	46.2	39.2	44.6	36.7	35.0	15.2	26.1	19.8
V		14	18.5	16.1	19.6	19.9	17.8	17.0	11.4	17.2	14.7	14.3	20.4	15.1
VI		21	25.6	18.0	20.1	13.0	16.4	16.2	24.9	10.3	22.0	24.2	20.6	26.0
VII		28	13.9	13.1	17.8	17.2	16.4	17.8	18.2	10.7	15.0	11.1	13.1	8.6
VIII	Aug.	4	17.2	7.0	10.3	3.8	12.5	7.0	7.1	18.3	9.4	2.5	8.9	2.8
IX		11	12.8	12.1	6.6	5.5	15.3	3.6	11.7	7.0	15.9	6.7	17.0	7.3
X		18	12.4	12.0	6.5	9.9	10.1	11.2	11.0	12.1	7.3	8.2	7.0	6.8

Table 17. Average percentage of increase in plant height at all the investigation dates, the ratio between varieties, and the ratio between the treated and the free section.

	Average increase rate		Ratio between varieties		Ratio between treated and Free sections	
	Taihei-Mochi	Toyokuni	Taihei-Mochi	Toyokuni	Taihei-Mochi	Toyokuni
	%	%	%	%	%	%
Free section	18.4	15.6	100.0	84.8	100.0	100.0
1.0-*sun* section	17.2	14.4	100.0	83.7	93.5	92.3
1.5-*sun* section	18.1	15.1	100.0	83.4	98.4	96.8
2.0-*sun* section	18.2	15.5	100.0	85.2	98.9	99.4
4.0-*sun* section	18.4	15.6	100.0	84.8	100.0	100.0
6.6-*sun* section	18.7	15.9	100.0	85.0	101.6	101.6

and the percentage of increase in height in each treated section to the increase in Free Section are shown in Table 17. Both varieties showed a lower rate in the average percentage of increase in plant height in proportion as they were more closely planted, the 6.6-*sun* section being the highest in percentage and 1.0-*sun* section the lowest. On the other hand, a comparison was made of the rate of increase between the two varieties, with 100 given as the rate of increase of

Table 18. Analysis of variance.

Changing factors	Sum of squares	Degree of freedom	Variance	Variance ratio (F-value)
Transplanting-density (T)	404.95	5	80.99	8.48***
Variety (V)	115.32	1	115.32	12.08***
Growing stage (S)	3263.11	3	1087.70	113.90***
V × T	32.65	5	6.53	—
V × S	169.52	3	56.51	5.92***
T × S	996.14	15	66.41	6.95***
V × T × S	143.19	15	9.55	
Total	5124.88	47	109.04	

Taihie-Mochi : Toyokuni showed 83–85 per cent or a little over in every section, the many-panicle type Taihei-Mochi being 15–17 per cent higher than the heavy-panicle type Toyokuni. In the comparison based on the difference in density of plants with 100 per cent given to Free Sections, the result was that 4.0–*sun* sections of both varieties showed 100 per cent as Free Sections, and that all the other treated sections showed a decrease against Free Sections, excepting that 6.6–*sun* sections increased by about 15 per cent.

Table 18 shows an analysis of variance concerning plant height.

(iii) Heading date of main stem.

The average heading date based on the measurement of each plant is given in Table 19. The average heading date of main stems in all the treated sections except the 6.6–*sun* section of Toyokuni hastened as compared with that in the Free Section, and a tendency was noted that the hastening was greater in proportion with the density of transplanting. This tendency was seen in both varieties. It was also noticed that the hastening due to the density of planting seemed to somewhat greater with Taihei-Mochi than with Toyokuni.

Table 19. Average heading dates.

	Varieties	Free section	1.0–*sum* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
Average heading dates in August	Taihei-Mochi	23.5	21.5	21.8	22.0	22.4	23.4
	Toyokuni	15.0	13.2	13.4	13.6	14.7	17.6
Days cut from those in Free section	Taihei-Mochi	—	2.0	1.7	1.5	1.1	0 1
	Toyokuni	—	1.8	1.6	1.4	0.3	-2.6

3. Result of investigation with the harvested plant.

(i) Stem length.

The length of the stem and that of the parts forming the stem, namely the peduncle and the part below it (the length of which will be named "basic stem length" are shown in Table 20.

Stem length was shortest in the most closely transplanted section, and it was longer in more sparsely planted sections, but the 2.0–*sun* section being the boundary, it was shorter again in proportion as the sections were more sparcely transplanted. To divide stem length into two parts as described above, the peduncle length of Toyokuni drew a similar curve to that of its stem length, while Taihei-Mochi did not decrease in peduncle length as Toyokuni but increased in it even when planted sparcely.

The tendency was that the bassic stem was long in proportion to the density of transplanting, its length decreasing in proportion as the plants were sparsely planted. In comparison with the Free Section, every treated section showed a

Table 20. Average stem length.

	Stem length & its parts	Varieties	Free section	1.0–*sun* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
			cm	cm	cm	cm	cm	cm
Actual measurements	Stem length	A	71.4	67.5	71.3	75.8	73.0	72.1
		B	82.3	75.4	81.7	85.5	84.2	82.5
	Peduncle length	A	31.7	28.2	35.0	38.6	38.6	39.5
		B	38.0	31.5	38.3	42.3	41.5	40.0
	Basic stem length	A	39.7	39.3	36.3	37.2	34.4	32.6
		B	44.3	43.9	43.4	43.2	42.7	42.5
Increase in treated sections *vs.* Free section	Stem length	A	—	−3.9	−0.1	4.4	1.6	0.7
		B	—	6.9	−0.6	3.2	1.9	0.2
	Peduncle length	A	—	−3.5	3.3	6.9	6.9	7.8
		B	—	−6.5	0.3	4.3	3.5	2.0
	Basic stem length	A	—	−0.4	−3.4	−2.5	−5.3	−7.1
		B	—	−0.4	−0.9	−1.1	−1.6	−1.8

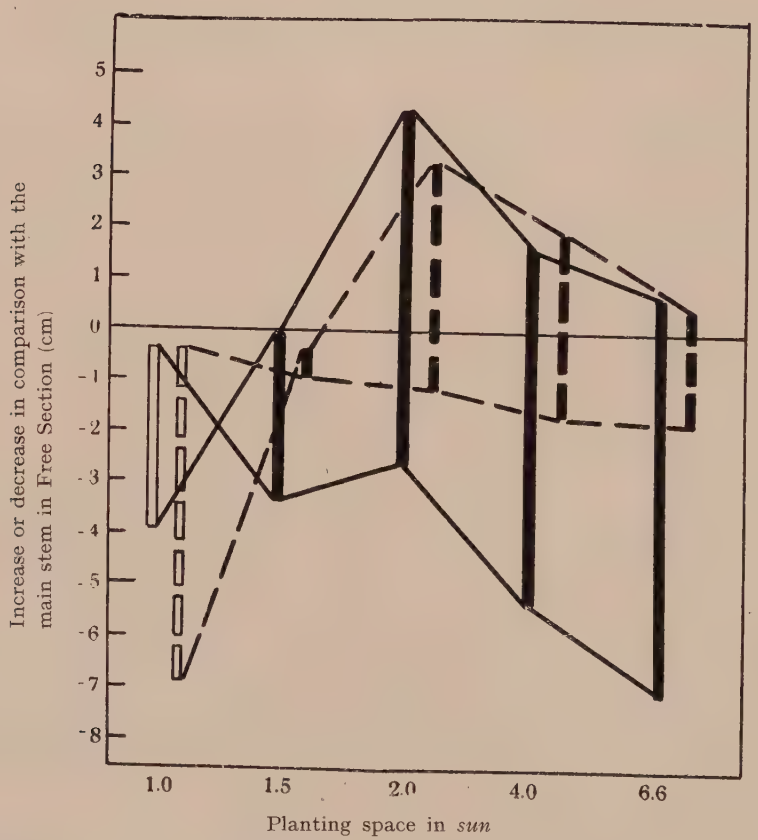

Figure 8. The amount of increase or decrease in the average stem length in treated sections as compared with the main stem in Free Section.

Table 21. Ratio between the peduncle and basic stem in length.

Length of stem & its parts	Varieties	Free section	1.0–*sun* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
		%	%	%	%	%	%
Stem length	Each varietiy	100.0	100.0	100.0	100.0	100.0	100.0
Peduncle length	Taihei-Mochi	44.4	41.8	49.1	50.9	52.9	54.9
	Toyokuni	46.2	41.8	46.9	49.5	49.3	48.5
Basic stem length	Taihei-Mochi	55.6	58.2	50.9	49.1	47.1	45.1
	Toyokuni	53.8	58.2	53.1	50.5	50.7	51.5

decrease ; of the two vaieties, Taihei-Mochi showed a greater decrease, which was as much as 7 cm in 6.6–*sun* section.

The ratio between these two parts in stem length is shown in Table 21. Namely, the values of peduncle length of Taihei-Mochi were increased in the order from 1.0 *sun* section to 6.6 *sun* section, or from close planting to sparse planting, but the tendency of increase of Toyokuni was such that the values were the greatest in 2.0–*sun* section, which were the boundary, and then the increase was a little slighter. These tendencies are illustrated in Figure 8. In this figure, Taihei-Mochi is shown by soild line, and Toyokuni by dotted line. Both lines indicate the comparisons with main stem in Free Section. Both the upper curves denote the alterations in stem length, and both the lower curves, the alterations in basic stem length ; the perpendicular lines connecting the upper and lower lines, therefore, denote the increments in peduncle length (excepting 1.0–*sun* section in which is shown the decrease in peduncle length).

(ii) Ear length and number of ear branches.

Table 22 shows the average ear length of each section. With 2.0–*sun* section as the boundary, the increase in ear length of treated sections was greater than that of Free Section in proportion to sparse planting in the order of 4.0–*sun* and 6.6–*sun* sections, while decreases as compared with Free Section were seen more in proportion to close planting in the order of 1.5–*sun* and 1.0–*sun* sections. There was no special difference recognized in increasing and decreasing tendencies between the two varieties.

Table 22. Average ear length of the main stem.

	Varieties	Free section	1.0–*sun* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
		cm	cm	cm	cm	cm	cm
Average ear length	Taihei-Mochi	21.3	16.1	20.6	22.0	24.5	25.0
	Toyokuni	20.2	15.0	18.8	20.5	23.1	23.8
Increase in treated *vs.* Free section	Taihei-Mochi	—	−5.2	−0.7	0.7	2.7	3.7
	Toyokvni	—	−5.2	−1.4	0.3	2.9	3.6

As is seen in Table 23, the average number of branches per ear was increased likewise in proportion to sparse planting and decreased in proportion to close planting. The 2.0–*sun* section, which showed a slight increase in ear length, showed a slight decrease in the number of branches per ear. The decrease was noted to be a little greater with Toyokuni than with Taihei-Mochi.

Table 23. Average number of branches per ear.

	Verieties	Free secton	1.0–*sun* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
Average number of ear branches	Taihei-Mochi	10.8	6.1	9.1	10.1	11.9	12.2
	Toyokuni	13.5	6.2	9.5	11.3	14.7	16.0
Increase in treated *vs.* Free section	Taihei-Mochi	—	−4.7	−1.7	−0.7	1.1	1.4
	Toyokuni	—	−7.3	−4.0	−2.2	1.2	2.5

(iii) Ear weight and number of grains per ear.

The average ear weight and the number of grains per ear are shown in Tables 24 and 25. In comparison with those of the Free Section, they were gradually increased as the sections were more sparsely transplanted, the 2.0–*sun* section being the boundary, and they showed a gradual decrease in the more closely planted sections. The decrease in the number of grains per ear was remarkable especially in more closely planted sections. Furthermore, these tendencies of increase and decrease were more marked with Toyokuni than with Taihei-Mochi.

Table 24. Average ear weight.

	Varieties	Free section	1.0–*sun* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
		g	g	g	g	g	g
Average ear weight	Taihei-Mochi	2.0	0.8	1.9	2.5	3.3	3.4
	Toyokuni	2.9	0.8	2.2	3.0	4.7	5.3
Increase in treated *vs.* Free section	Taihei-Mochi	—	−1.2	−0.1	0.5	1.3	1.4
	Toyokuni	—	−2.1	−0.7	0.1	1.8	2.4

Table 25. Average number of grains per ear.

	Varieties	Free section	1.0–*sun* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
Average number of grains per ear	Taihei-Mochi	117.2	50.7	90.1	111.1	136.4	148.6
	Toyokuni	127.7	54.4	92.5	123.5	192.3	211.3
Increase in treated *vs.* Free section	Taihei-Mochi	—	−66.5	−27.1	−6.1	19.2	31.4
	Toyokuni	—	−73.3	−35.2	−3.2	64.6	83.6

(iv) Percentage of fertile grains and wieght of 100 grains.

A sis shown in Table 26, the percentage of fertile grains was noticed to increase

in proportion as sections were more sparsely planted, *viz.* in the order of 2.0–*sun*, 4.0–*sun* and 6.6–*sun* sections, while on the contrary it showed a gradual decrease in the order of 1.5–*sun* and 1.0–*sun* sections so that it was lower than that in the Free Section. The tendency was that the increase was a little higher with Taihei Mochi than with Toyokuni.

Table 26. Percentage of fertile grains.

	Varieties	Free section	1.0–*sun* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
		%	%	%	%	%	%
Percentage of fertile grains	Taihei-Mochi	82.9	73.7	82.1	87.3	91.7	93.8
	Toyokuni	84.9	79.7	84.1	85.1	90.2	92.7
Increase in treated *vs.* Free section	Taihei-Mochi	—	−9.2	−0.8	4.4	8.8	10.9
	Toyokuni	—	−9.2	−0.8	0.2	5.3	7.8

Hulled rice grains were picked up at random from each experimental section to form 9 groups each containing 100 grains, and each group was weighed. The result is given in Table 27. It shows that there was a tendency that the average grain weight in each section except 1.0–*sun* section was a little heavier than that in the Free Section in proportion as a section was more sparsely planted. This tendenccy was more marked with Taihei-Mochi than with Toyokuni.

Table 27. Weight of 100 hulled grains.

	Varieties	Free section	1.0–*sun* section	1.5–*sun* section	2.0–*sun* section	4.0–*sun* section	6.6–*sun* section
		g	g	g	g	g	g
Weight of 100 grains	Taihei-Mochi	1.66	1.62	1.87	1.96	1.99	2.00
	Toyokuni	2.01	1.87	2.16	2.18	2.19	2.21
Increase in treated *vs.* Free section	Taihei-Mochi	—	−0.04	0.21	0.30	0.33	0.34
	Toyokuni	—	−0.14	0.15	0.17	0.18	0.20

IV. Discussion

To sum up Experiments 1 and 2, it is clear in the present results and also in the report by Morita[6] that the restriction of number of tillering sprouts or the picking of all tillers leaving only the main stem causes as the effects various quantitative changes. The restriction of number of sprouts may be taken as a change in the circumstantial conditions of the over- and underground parts of each plant, and especially, to transplant very thickly is to place the over- and underground parts of the rice plant itself under unfavorable circumstantial conditions, hence, it can easily be imagined that the supposed existence of the potentiality which may be called a subjective vitality existing within the rice plant itself should cause some change in the speed of its growth. This means that

Table 28. The maximum and minimum increase rates in contrast with the Free Section in Experiment 1 (%).

Properties	Maximum increase rates				Minimum increase rates			
	Taihei-Mochi		Toyokuni		Taihei-Mochi		Toyokuni	
	Number of sprouts per plant	Increase rates	Number of sprouts per plant	Increase rates	Number of sprouts per plant	Increase rates	Number of sprouts per plant	Increase rates
Main stem: Number of leaves or nodes	1	17.3	1	14.1	15	1.9	15	0.6
Stem length	5	3.1	5	2.1	1	−9.1	1	−10.6
Peduncle length	5	21.0	5	14.7	1	8.8	1	6.0
Basic stem length	15	−4.8	15	−3.0	1	−23.9	1	−24.1
Ear length	1	12.3	1	20.2	15	5.7	15	0.3
Number of branches per ear	1	18.8	1	24.8	15	4.6	15	6.4
Ear weight	1	111.8	1	76.0	15	50.0	15	18.2
Number of grains per ear	1	85.5	1	67.1	15	18.8	15	7.6
Percentage of fertile grains	1	13.3	1	3.6	15	6.2	10	1.9

Note : Here also, comparisons were made with the tillers at the corresponding nodal positions.

Table 29. The maximum increase rates and the maximum decrease rates in contrast with the Free Section in Experiment 2 (%).

Properties	Maximum increase rates				Maximum decrease rates			
	Taihei-Mochi		Toyokuni		Taihei-Mochi		Toyokuni	
	Sections (*-sun*)	Increase rates	Sections (*-sun*)	Increase rates	Sections (*-sun*)	Decrease rates	Sections (*-sun*)	Decrease rates
Main stem: Number of leaves or nodes	6.6	12.5	6.6	8.0	1.0	15.9	1.0	18.3
Stem length	2.0	6.2	2.0	3.9	1.0	5.5	1.0	8.4
Peduncle length	6.6	24.6	2.0	11.3	1.0	11.0	1.0	17.1
Basic stem length	1.0	−1.0	1.0	−0.9	6.6	17.9	6.6	4.1
Ear length	6.6	17.4	6.6	17.8	1.0	24.4	1.0	25.7
Number of branches per ear	6.6	13.0	6.6	18.5	1.0	43.5	1.0	54.1
Ear weight	6.6	70.2	6.6	83.0	1.0	57.6	1.0	68.4
Number of grains per ear	6.6	26.8	6.6	65.5	1.0	56.7	1.0	57.4
Percentage of fertile grains	6.6	13.2	6.6	9.2	1.0	11.1	1.0	10.8
Weight of 100 grains	6.6	20.5	6.6	10.0	1.0	2.4	1.0	7.0

the more restricted is the number of sprouts, or the fewer are the remaining sprouts, the more increased is the change and the more accelerated is the growth of the rice plant. Then, will the dynamic conditions of change similar to those which are seen in the above case be caused by such circumstantial changes as dense or sparse transplanting to appear in the plant (main stem) which is made independent of the effects of tillerrs by the picking of them ? And if the restriction of sprout number and the separation of plants produce different forms of effeccts, in what properties of the rice plant and in what shape will such effeccts appear ? To answer these questions may be said to be very important in the analysis of the circumstantial reactions of different types of growth habits of rice plant. The approximate values of the maximum and minimum quantitative changes in the present experiments as contrasted with the changes in the Free Section will be tabulated in Tables 28 and 29.

1. An Analysis of the phenomenon of changes that occurs in quantitative properties.

So far as the treatments and investigations in the present experiments are concerned, the most remarkable quantitative change due to the restriction of number of sprouts or the picking of tillers was seen in ear weight, thus it is clear that ear weight is the most susceptible to the changes, both increase and decrease, in these circumstantial conditions. And this fact, as has been stated earlier, does not mean the possible sham differences based on the average values in which fewer numbers of ears on late tillers are included in the sections of restricted number of sprouts as compared with the Free Section, nor from there being only main stems in the sections where all the tillers were picked. To examine ear weight, which showed the most remarkable quantitative changes, according to its components : the greatest change is seen in the number of grains per ear, followed by the number of branches per ear, ear length and the percentage of fertile grains in order of mention. The number of main stem nodes (or the number of main stem leaves) and stem length also showed some changes, but the inecrease and decrease rates here are very low, being approximately 10–15 per cent of those in ear weight. Anyhow, it is clear from these quantitative alterations that ear weight is a property most susceptible to the influences of these treatments. The movements in these quantitative properties are illustrated in Figures 9 and 10.

The number of main stem leaves or main stem nodes is increased in proportion as the number of sprouts is more severely restricted. The picking of all tillers leaving alone the main stem is accompanied by a greater increase in proportion as the distance between the plants is made greater. With stem length it is somewhat different from the case of the number of main stem leaves : the restriction of the number of sprouts is accompanied by a greater increase in proportion as the number is restricted more severely as far as it becomes five, but in 1–sprout section the stem length is shorter than that in the 15–sprout section

where the number of sprouts per plant is the largest, and has the lowest value in all the experimental sections. In the experiment in the picking of tillers, likewise, the 2-*sun* section shows the greatest increase, while the more sparsely planted sections, showing greater values than the restricted sections, have a small increase, and the more thickly planted sections as 1.5 or 1.0-*sun* sections hold smaller values than those in the Free Section. As regards the number of main

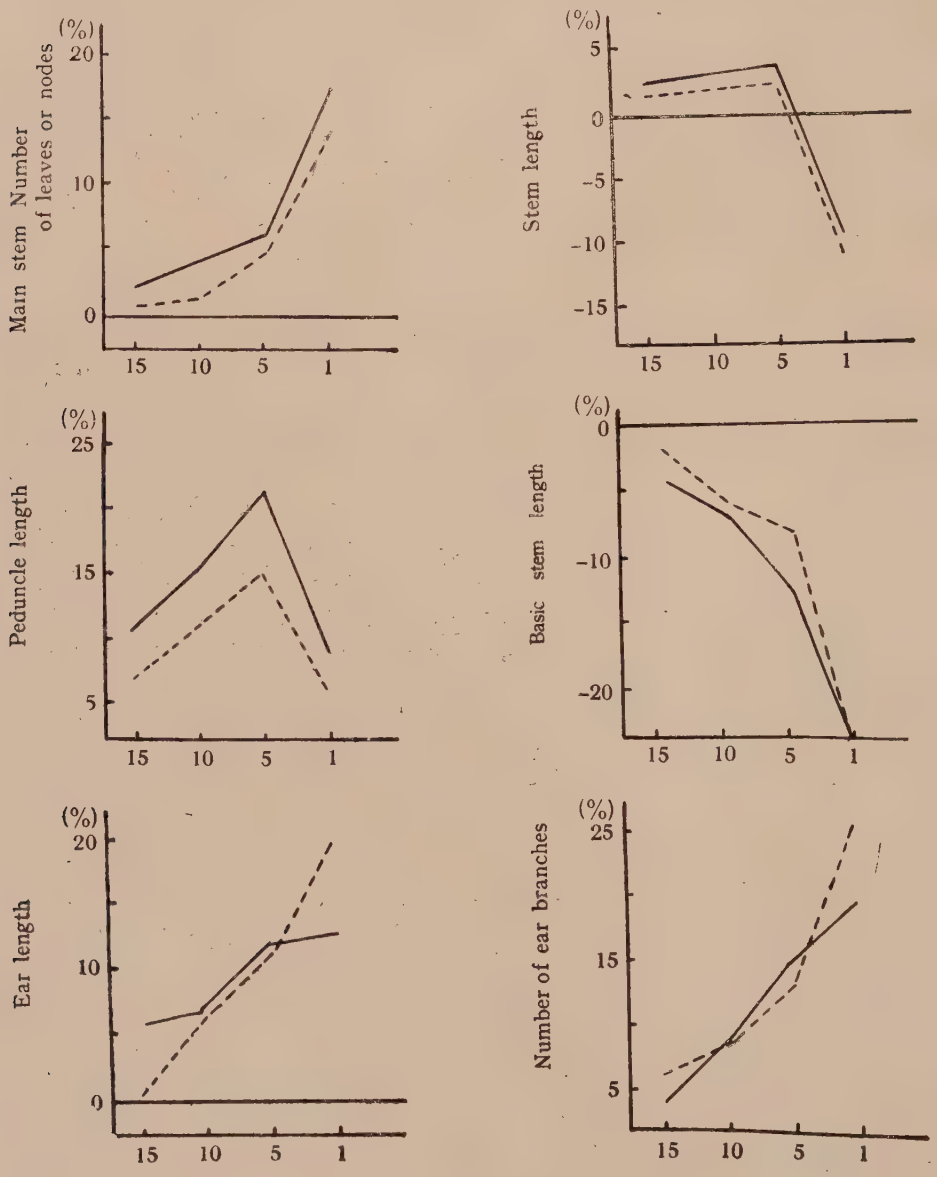

Fig. 9 (1).

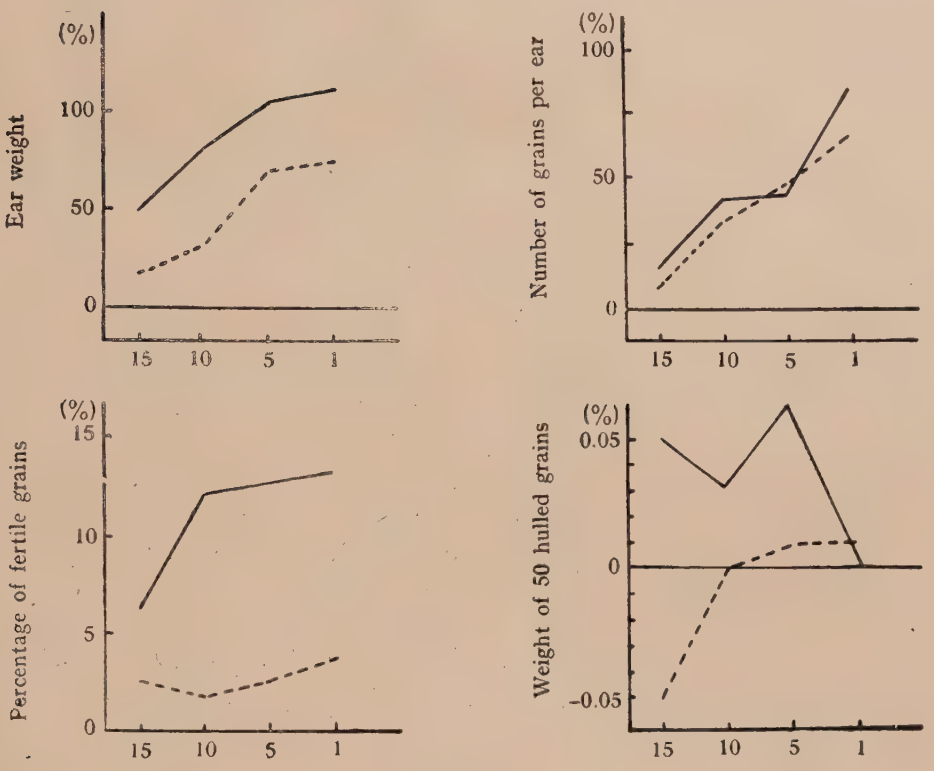

Fig. 9 (2).

Figure 9. Alterations in quantitative characters in contrast with those in Free Section (Experiment 1.)

Solid lines, Taihei-Mochi ; dotted lines, Toyokuni. The rate of increase or decrease in each character is contrasted with that in the same character in Free Section.

stem nodes, the restriction of sprout number brings about the greatest increase in the 1–sprout section and the picking of tillers in the 6.6–*sun* section, but the increase in the number of nodes and that in stem length do not always go together. A similar phenomenon was recognized by Morita[6] in the alterations of the number of main stem nodes due to his special treatment leaving alone the main stem of the rice plant, but in the present experiments the fact was seen that the increase in the number of main stem nodes does not appear in the increase in the number of the nodes concerning extensor-internodes. Both of the experimental varieties show the same rise in the increase in peduncle length, which is a part of stem length, accompanying severe restriction of sprout number, the greatest increase being seen in 5–sprout section, while a smaller increase is seen in 1–sprout section. On the other hand, the nipping of tillers resulted in that the many-panicle type Taihei-Mochi shows smaller increases in sections with wider spacings than 2 *sun*, while the heavy-panicle type Toyokuni does not show a fall in increase in sections

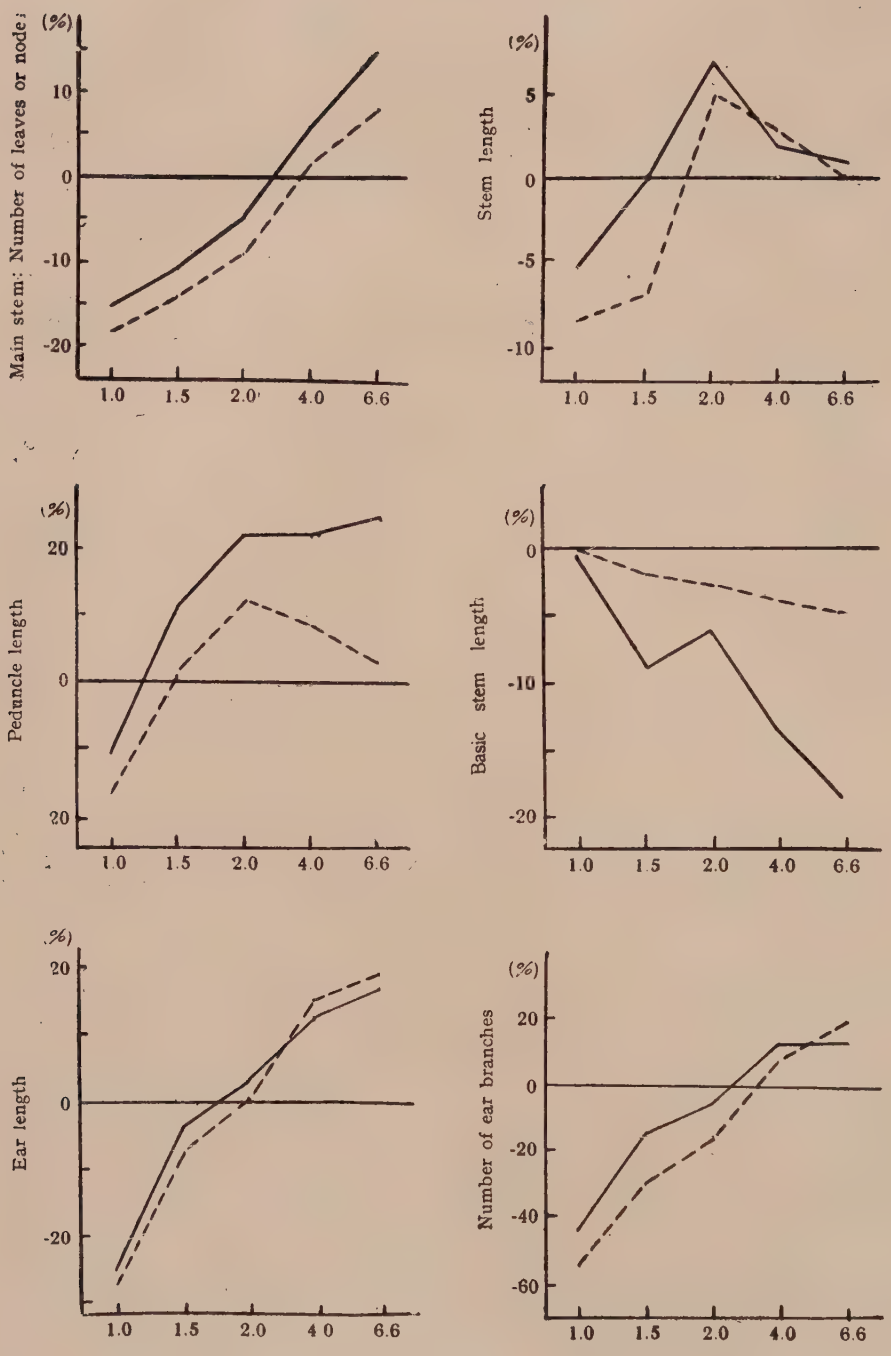
Main stem: Number of leaves or node
(%)
10
0
-10
-20
1.0
1.5
2.0
4.0
6.6
Stem length
(%)
5
0
-5
-10
Peduncle length
(%)
20
0
20
Basic stem length
(%)
0
-10
-20
Ear length
(%)
20
0
-20
Number of ear branches
(%)
20
0
-20
-40
-60

Fig. 10 (1).

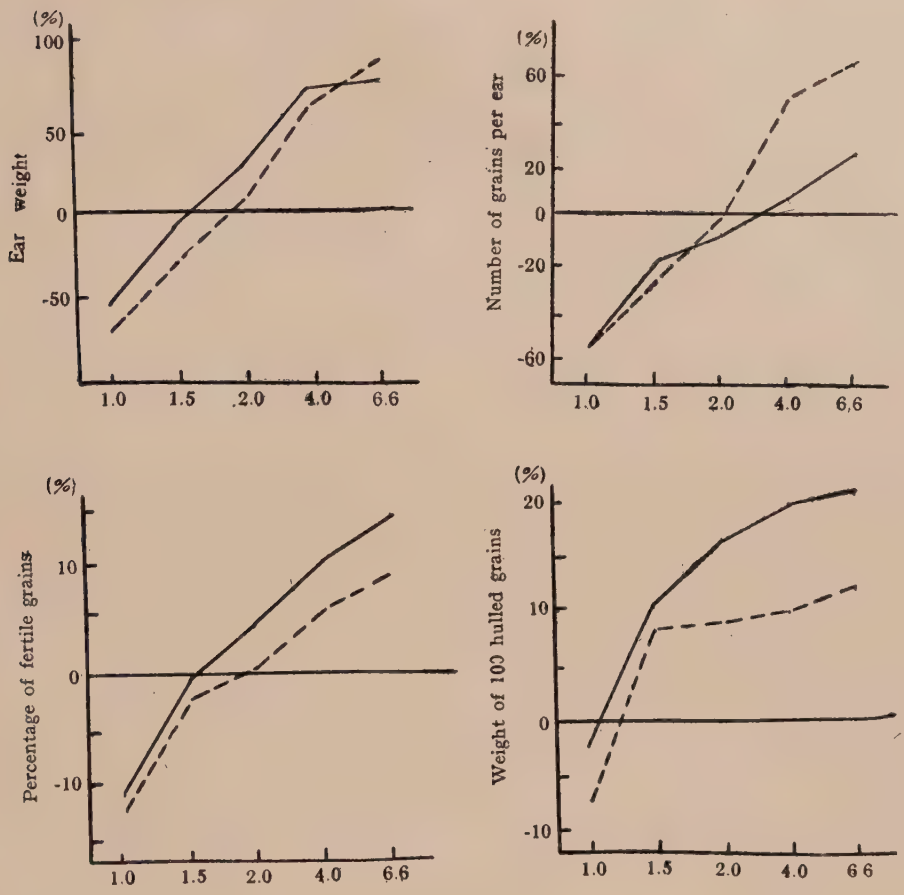

Fig. 10 (2).

Figure 10. Alterations in quantitative characters in contrast with those in Free Section (Experiment 2.)

Solid lines, Taihei-Mochi ; dotted lines, Toyokuni. The rate of increase or decrease in each character is contrasted with that in the same character in Free Section.

with narrower spacings than 4.0 *sun*. This may be caused by those different responses to different densities of plants which are manifested in the greatest peduncle length based on the difference in types of growth habits ; and it seems due to the fact that the full growth of the ear gives a negative effect on the elongation of the peduncle so that it cannot accelerate the rising tendency in the increase in peduncle length accompanying sparse planting, if it is considered connectively with the facts that the main growth of the peduncle is done at the rapid elongation period following the young-ear forming period and that the number of grains per ear is especially large in the 1–sprout section with restricted number of sprouts and in the 4.0–*sun* and 6.6–*sun* sections in the case of Toyokuni.

Furthermore, the regeneration of pinched tillers (all the regenerated tillers were pinched as soon as they were found), which continued till shortly before the young-ear forming period and was so active particularly in 1–sprout section in the case of restriction of sprout number and in 4.0–*sun* and 6.6–*sun* sections, *i.e.* sparsely planted sections in the case of pinching tillers, is supposed to have given more or less influence on the decrease in peduncle length. As for the part of stem length below the above-described peduncle, the result is that a gradual decrease is seen in proportion as the restriction of sprout number gets severer or the plants are transplanted more sparsely with the tillers pinched, every experimental section showing nothing but a decrease as compared with the Free Section. This seems due to the reason that the full growth of the ear has restraining influence on the elongation of this part. To sum up; it seems that among the various changes caused by different handling and manipulations in the present experiments, the growth and perfection of the ear receives a greater influence than the elongation of the main stem, and that in the elongation of the stem, the elongation of the peduncle is more liale to be effected than that of any other part.

The comparison of ear weight and some of its components, namely the number of grains per ear, the number of branches per ear and ear length, between treated sections only, shows a rectilineal increase as the restriction of sprout number gets more severer or the plants are planted more sparsely. The increase in ear weight is, as has been stated earlier, mainly due to the increase in the number of grains per ear. The increase rates of the number of branches per ear are low as the increase rates of ear length, and it is clear that the increase in the number of grains per ear is due mainly to the increased density of glume setting. Morita[6] also stated that his special treatment resulted in a remarkable increase in the number of grains per ear, though ear length did not go together. The period in which the number of grains per ear is decided is, as is already known, from the period of glume differentiation till the meiotic stage of germ-cells, hence it is well known that the external conditions of circumstances and internal conditions of nutrition under which the rice plant is placed in this period is most closely connected with the decision of the number of grains per ear, unless it suffer from unexpected special damages as from cold weather, drought or inundation. It may well be considered, therefore, that the increase in the density of glume setting due to the restriction of sprout number in the present experiment comes from the change in circumstantial conditions, *viz.* the decrease in the number of sprouts per plant. The same casue is also responsible for the increase in the density of glume setting which appeared in proportion to sparse planting. The fact that the percentage of fertile grains and the wieght of hulled grains showed comparatively a little increase due to severer restriction of sprout number or sparser planting is considered to mean that the increase in these properties was checked by the increase in the number of grains per ear. A remarkable decrease

in more sparsely planted sections with pinched tillers as compared with the Free Section is also the case of ear weight. Here, too, the fall in ear weight can be ascribed to the decrease mainly in the number of grains, followed by the number of branches per ear. The decrease in these two, which is approximately 50 per cent as compared with those in the Free Section, is very remarkable in contrast with the decrease in ear length and percentage of fertile grains. It may be considered that physiological checking of the formation of young-ear is effected together with the decrease in plant height, number of leaves and others by the insufficient development of the underground parts, as is shown in fact by the observation of the roots, and by the unfavorable circumstances above the ground owing to close planting. This explanation may become more convincing if the report by Cho[7] is referred to, in which he says that there is an appreciably positive correlation between root weight and root number on one hand and ear weight on the other.

2. Verocity of development and growth.

As regards the appearance of main stem leaves at the same nodal positions and the elongation of sprouts, an acceleration was observed in the case of restricting sprout number approximately at III-IV Investigation Dates first in 1–sprout section followed by 5–, 10– and 15–sprout sections in order. This is a natural result, as it is caused by the fact that the dates of nipping the first tillers in their respective sections became later in the order of mention. In the case of nipping tillers, the first acceleration was seen in 6.6–*sun* section which was the most sparsely planted, followed by 4.0–*sun* section. As for plant height, an acceleration was noticed in 2.0–, 1.5– and 1.0–*sun* sections even later than V Investigation Date, while these sections showed no acceleration in the time of appearance of the main stem leaves at the same nodal positions but some delay instead as compared with the Free Section. These facts were referred to by Morita[6] who stated that an extreme improvement of nutrition causes an increase in the number of main stem leaves. Matsuo[9] stated that such a method of cultivation as checks the vegetative growth of the plant causes a decrease in the number of main stem nodes and that the density of planting has a comparatively close relationship with the number of main stem nodes. The decreases in the number of main stem leaves observed in the present experiments are considered to have resulted from very close planting such as 900 plants per *tsubo* in 2.0–*sun* sections, 1,600 plants per *tsubo* in 1.5–*sun* sections and 3,600 plants per *tsubo* in 1.0–*suvn* sections. Towards the heading time, the phenomenon of acceleration is lowered or stopped in the development of main stem leaves at the same nodal positions and in the elongation of plant height. This is probably because of the fact that the formation of young ears is under way around the VII–VIII Investigation Dates and owing to the transition from vegetative growth to generative growth the function of the ear to grow and perfect itself gives a checking influence to the promotion of the main stem leaves as well as of the plant height.

The heading date of each sprout in the case of restriction of number of sprouts is accelerated in proportion as the restriction is heavier. In the same way as described in the case of ear weight, it is not due to the reason that a section with fewer sprouts contains fewer late tillers. In the nipping of sprouts, the more closely planted is a section, the more accelerated is its heading date. Katayama[8] has stated that the correlation between the number of main stem nodes and the heading time is very high, and Matsuo[9] has also recognized that the correlation coefficient between the two is over 90 per cent as in the case of Katayama. The acceleration of heading time owing to the increase in density of plants in the present experiments, where the main stems were left alone (nipping all tillers), seems to have been caused by the fact that close planting, a change in environmental conditions, brings about a decrease in the number of main stem nodes, being followed by quickening the formation of young ears.

Anyway, the variations arising from the restriction of stem number and the change of planting density by means of leaving only the main stems are : in the case of restriction of stem number, increase in the number of nodes, increase in plant height and acceleration of heading ; and in the case of nipping of tillers, increase in the number of nodes in sparsely planted sections, and decrease in that in closely planted sections, increase or decrease in plant height and acceleration of heading in closely planted sections — various changes in the growth and development of the plant. However, it is clear that from the young ear forming time on, a greater influence appears on the growth and completion of the ear than on the growth and acceleration of any other organ.

3. Difference between varieties.

Two varieties, Taihei-Mochi as a many-panicle type and Toyokuni as a haevy-panicle type, were used as samples. As they are respectively only one variety of the type, it would of course be premature to compare the experimental results between these two varieties as the representatives of the many-panicle and heavy-panicle types. The comparison, however, of both vaireties so far as the present experiments go, is made as follows :

Of the characters in which some effects were clearly recognized in these two experiments, ear length and ear weight showed no special difference in effect between the two varieties. But a tendency was recognized that the increase in the number of main stem leaves or main stem nodes and stem length is greater with Taihei-Mochi than with Toyokuni. This may mean that the restriction of sprout number leaving the same number of stems and the nipping of sprouts leaving only the main stem exerted a greater influence on Taihei-Mochi than on Toyokuni because the former, which is of the "many panicle" type, has a greater sprouting power than the latter. It may also be by the same reason that there is a tendency that the acceleration of heading date is somewhat greater with Taihei-Mochi.

In the growing process in plant height, the amount of increase gets smaller

as it draws nearer the heading time and the decline is greater with Toyokuni than with Taihei-Mochi. This is probably due to the fact that Toyokuni is a variety of the "heavy panicle" type with its ears by far the larger than those of Taihei-Mochi, thus exerting a stronger influence on the increase in plant height. Though there is no special difference in the increase and decrease rates of ear length and ear weight between the two varieties, the alterations in the number of ear branches and that of grains per ear are somewhat greater with Toyokuni. The alteration in the number of grains per ear is caused chiefly by the density of glume setting, and the many-panicle type shows a smaller difference between the main stem ear and the ear of later sprouting, and the heavy-panicle type yields a remarkably larger ear on its main stem.[10] It may mean that, with Toyokuni, the effect of the nipping of tillers which leaves only the main stem does not appear clearly in the plant height unlike the case with Taihei Mochi, but it does appear vividly in the enrichment of ears.

Taihei-Mochi is essentially an awnless variety, but in closely planted sections with all the tillers nipped, a certain top glumes beame to have short awns. This is a problem to be solved by future studies, though Tabata et al.[11] have observed in his photoperiodic experiment that a short-day treatment causes an awned variety to become almost awnless, and Hara[12] has stated that such varieties as would be awnless under short-day lighting or natural lighting had produced short awns on a certain top glumes under 24 hour lighting.

V. Summary

1. Investigations were made with Taihei-Mochi of the many-panicle type and Toyokuni of the heavy-panicle type of rice plant on the effects of the restriction of sprouting upon the characters by means of restricting the sprout number in the First Experiment in which were provided five different sections, *i.e.*, 1–sprout, 5–sprout, 10–sprout, 15–sprout and Free Sections; and on the effects of density of planting upon the characters of the main stem sprouts by means of nipping all tillers (only the main stem being left) in the Second Experiment in which were provided sections of different degrees of density, *viz.*, 1–*sun*, 1.5–*sun*, 2–*sun*, 4–*sun*, 6.6–*sun* sections and, as a control, Free Sections with 6.6–*sun* spacing.

2. The character in which the most conspicuous change occurred was ear weight; and of its components, the number of grains per ear showed the greatest change in increase or decrease, followed by the number of branches per ear, ear length and percentage of fertile grains in order of mention. The number of main stem nodes and stem length also showed some change due to those managements.

3. The increase in the number of grains per ear owing to the difference in sprout number and density of planting was attributed chiefly to the increase in the density of glume setting.

4. Of the various changes owing to these two kinds of managements, the changes in the characters of the ear are apt to be greater than those in others such as the elongation of the stem, and as for the stem length, the change in peduncle length is apt to be greater than that in the other part of the stem.

5. The appearance of main stem leaves at the same nodal position was accelerated in the management of restricting sprout number. In the management of nipping the tillers, it was quickened in more sparsely planted sections but delayed in more closely planted sections. The same was the case with the elongation of plant height. Heading was accelerated in proportion as the restriction of sprout number was heavier and sections were more closely planted. At the period of growth and enrichment of the ear, the growth and enrichment of the ear underwent a greater influence of the managements than the acceleration of growth of main stem leaves and stem length.

6. Though Taihei-Mochi is essentially of the awnless type, some short awns were recognized to grow on a certain top glumes of the ear in closely planted sections with tillers nipped.

7. The tendency was that the increase or acceleration rate in the number of main stem leaves, heading time, stem length and percentage of fertile grains was higher with Taihei-Mochi than with Toyokuni. The alterations in the number of branches per ear and that of grains per ear were somewhat higher with Toyokuni. There was no special difference in the alterations of ear length and ear weight between the two varieties.

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Some Observations on the Behavior of the Soft-Rot Bacteria in the Rhizosphere of Chinese Cabbage (*Brassica pekinensis*)

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(Received June 10, 1953)

I. Introduction

Observations on the seasonal trend in number of the soft-rot causing bacteria in infested soil have been reported in a previous paper[1]. Their laxuriant growth in field soil was found to correspond with the relative abundance of gram-negative ones, especially in the seasons of early summer and early fall when the disease usually outbreaks. This fact suggests that their activities may vary under the influences of various soil conditions, many other members of soil-microflora, and plant growth.

Recently it has been recognized that plant roots play an important role in the underground prosperity of soil-borne plant pathogens. Timonin (1940)[2] reported that a greater number of bacteria harbored in the rhizosphere of susceptible flax varieties than in that of the resistant ones. He (1941)[3] also showed that roots of wilt-resistant flax variety secreted sufficient amounts (24–34 mg) of HCN to inhibit the growth of wilt fungus (*Fusarium lini* Bolley) in the culture media. From his results a possibility may arise that hydrogen cyanide secreted from flax roots would be directly responsible for the differences of varietal resistance of flax, and there is also the alternative possibility that luxuriant growth of *Trichoderma viride* may be promoted, which effects an antagonistic action to the wilt fungus.

Valleau and his associates (1944, 1946)[4][5] demonstrated that *Pseudomonas tabaci* and *P. angulata* from tobacco and *Xanthomonas vesicatoria* from tomato can support themselves on the surface of living roots of various non-host plants and thus survive the winter season. *Pseudomonas phaseolicola* and *Xanthomonas*

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* The 92nd report of the Institute for Agricultural Research, Tohoku University (1953)

phaseoli are unable to do this. Burkholder (1948)[6] suggested that "a few pathogens appear to have the ability to live for long periods, if not indefintely, in the soil. *Agrobacterium tumefaciens*, *Erwinia carotovora*, and *Pseudomonas solanacearum* have this reputation. All three, however, have an extensive host range and may be living on the roots and crowns of various plants instead of in a saprophytic stage." Such relationship between pathogen and plant roots is not only an interesting problem in the life cycle and ecological niche of plant pathogenic bacteria in soil but also from the standpoint of practical disease control.

In the present paper the authors report their results from the observation on the rhizosphere effects of the chinese cabbage on the colonization of the soft-rot bacteria (*Erwinia aroideae* (Towns.) Holl.).

II. Number of the soft-rot bacteria and other soil micro-organisms in rhizosphere of the chinese cabbage

1. Materials and methods

With qualitative bacteriological investigation in the rhizosphere it is necessary to take certain considerations on the procedures of sampling and the expression of the results obtained. In spite of the general agreement of sampling procedure by many workers, with the basis to be employed for the expression of microbial number they are not necessarily in agreement. Clark (1949)[7] summarized in his review the bases for the expression of microbial number as (a) per gram of root-surface scrapings; (b) per gram of gross sample, that is, whole roots with adhering soil; (c) per gram of adhering soil fractions of the gross root sample; and also as (d) number in successive washing of root sample and (e) number per square centimeter of root surface. Canadian workers (Lochhead, 1940[8], Timonin, 1940[2]) expressed the microbial number as per gram of oven dry soil adhering on rootlets and root hairs, regardless of the amount of sampled root, to evaluate the density of microorganisms inhabiting in rhizosphere soil. The present authors followed the Canadian workers.

Five grams of gross sample including roots and adhering soil were taken carefully into a sterilized flask and 45 grams of sterilized water were added. The flask was then shaken for five minutes to prepare the original soil solution. Several dilutions in the order of 10^{-2}, 10^{-3}, ... 10^{-8} were prepared from the original soil solution. One cubic centimeter of each soil solution (10^{-5}, 10^{-6}, 10^{-7} and 10^{-8}) was poured into a Petri dish with aliquot volume of melted agar medium, and incubated at 30°C for 48 hours. Modified Drigalski's agar medium was used for counting the number of gram-negative bacteria including *E. aroideae* and albumin agar medium for counting the total number of bacteria and actinomycetes.

After removing the roots from the soil solution the content of the flask was poured into an evaporating dish to dry over a boiling water-bath. Then the dried

soil was weighed to permit the estimation of plate count on dry weight basis.

To compare with the microbial number inhabiting in rhizosphere, soil was taken from the middle part between ridges and its microbial number was counted after the above-mentioned procedures. In the case of a green-house experiment control soil was taken from the soil remaining in the pot after the test plants had been removed.

2. Experimental results

(i) Field experiment: The relation between bacterial number inhabiting in rhizosphere of the chinese cabbage and its growth stage. Investigations were made in the field of our institute, wherein chinese cabbage cultivation has suffered every year from the severe outbreak of the soft rot disease. Two varieties of the chinese cabbage, Miyagi-nigo and Chitose were grown. Seeds were sown on August lst, 1952, The first sampling was made on the 18th of the same month, and thereafter successive examinations were performed every week or biweekly.

As shown in Table 1, the bacterial number in rhizosphere soil was far greater than that in the control soil throughout the investigation. Number of colonies appeared on Drigalski's agar medium containing rhizosphere soil was about 100–1000 times as much as that containing the control soil, and also in total bacterial number the former was about 10–600 times as much as the latter.

Table 1. The relation between number of micro-organisms and successive growth stages of the chinese cabbage.

Date of sampling	Soil moisture content %	No. of bacteria appeared on modified Drigalski's medium ($\times 10^6$)				No. of bacteria appeared on albumin agar medium ($\times 10^6$)			
		Control soil	Rhizosphere Miyagi-nigo	Control soil	Rhizosphere Chitose	Control soil	Rhizosphere Miyagi-nigo	Control soil	Rhizosphere Chitose
1952 Aug. 18	17.5	1.2	110.0	1.8	200.0	22.0	280.0	49.0	670.0
26	20.0	2.7	260.0	2.9	280.0	100.0	2500.0	61.0	500.0
Sept. 2	23.0	1.3	130.0	1.8	150.0	17.0	2900.0	46.0	3300.0
9	19.0	4.3	990.0	3.5	290.0	47.0	3900.0	49.0	3500.0
17	22.5	5.2	870.0	2.5	340.0	82.0	3900.0	80.0	7600.0
22	16.5	15.0	1520.0	4.3	350.0	180.0	14600.0	130.0	12800.0
Oct. 2	22.0	2.3	2110.0	3.4	1510.0	45.0	18700.0	25.0	7300.0
27	25.5	1.8	2400.0	3.6	170.0	42.0	25800.0	47.0	1400.0

Bacterial number in rhizosphere soils of both varieties increasd with progressive stages of plant growth, especially at the wrapping stage of the host plant (about middle of September). However, as shown in Table 1, such a trend differed thereafter for each variety. With Miyagi variety it continued further to increase until the last sampling day (Oct. 17), while with Chitose variety reached the maximum at the 21st of September and then gradually decreased. The trend

Table 2. Percentages of the rotted carrot-slices inoculated with rhizosphere soil solution of different dilutions.

Order of dilution	Percentages of rotted carrot-slices after 48 hours incubation			
	10^{-1}	10^{-2}	10^{-3}	10^{-4}
Rhizosphere soil solution of Miyagi-nigo var.	100	100	100	100
Control soil solution of Miyagi-nigo var.	60	40	20	40
Rhizosphere soil solution of Chitose var.	80	60	40	20
Control soil solution of Chitose var.	40	40	30	30

of bacterial number in the control soil showed a tendency similar to that of the latter case. An attempt to determine the relation existing between the activity of soft-rot bacteria and growth-stage of the chinese cabbage by the carrot-slice method[11] failed owing to the natural infection of the test carrot. It could be assumed from the result obtained by the last sampling (Table 2), however, that the soft-rot bacteria may harbor abundantly in rhizosphere soil in comparison with them in the control soil. The abundant occurrence of bacterial colonies with yellow nucleus and transparent margin on modified Drigalski's medium containing rhizosphere soil solution also indicated the abunadant existence of soft-rot bacteria.

To ascertain the existence of soft-rot bacteria in rhizoshpere, the following experiment was carried out. Blocks of soil around plant roots were carefully dug up and the adhering soil was gently removed to release the healthy plant root.

Table 3. Inoculation test on healthy petioles of chinese cabbage with roots.

Treatment	No. of petioles inoculated	No. of petioles diseased	Percentage diseased
Experiment 1 : 5th October, 1952			
Inoculated with roots exposed on soil surface	40	34	85
Inoculated with roots submerged in soil	40	22	55
Control	20	0	0
Experiment 2 : 10th October, 1952			
Inoculated with roots exposed on soil surface	40	27	67
Inoculated with roots submerged in soil	40	32	80
Control	20	0	0
Experiment 3 : 25th October, 1952			
Inoculated with roots exposed on soil surface	40	17	43
Inoculated with roots submerged in the soil	40	16	40
Control	20	0	0

Pieces of root about 2 cm long were prepared from the roots appearing over the soil surface and the roots submerged in the soil. Each of them was imbedded in healthy petioles and placed in a moist chamber at 30°C for 48 hours, and examined the occurrence of rotting. The inoculation tests were made thrice namely, on the 5th, 15th, and 25th of October. The results are shown in Table 3. Fourty to eighty five per cent. of the inoculated petioles showed typical soft-rot symptom. Pathogenic isolates could be obtained from the rotted portion and all of them showed similar cultural characteristics to those of *E. aroideae*. This fact indicates that soft-rot bacteria may inhabit even on the root surface of apparently healthy plant.

(ii) Activity of soft-rot bacteria in rhizosphere.

The following experiments were carried out to ascertain the rhizosphere effect on the activity of soft-rot bacteria. Field soil (sandy loam), which had desiccated for 3 months in the green-house and secured the absence of soft-rot causing bacteria by the usual method, was filled in a pot. For each pot six grams of ammonium sulphate, three grams of calcium superphosphate and of potassium chloride were given. Half of the pots were inoculated with *E. aroideae* and the other half were kept as the control. Inoculation was performed by the following procedures.

Twenty cubic centimeters of bacterial suspension, collected from 5 agar slant cultures by washing twice with sterilized water, were sprayed with an atomizer for each pot. Then sterilized seeds of Miyagi-nigo variety were sown on the lst of September and the pots were placed in the green house. During September the plants grew normally under these conditions. On entering October they stopped to grow owing to the lowering of temperature, and again began to grow

Table 4. Percentages of the rotted slices inoculated with rhizosphere soil solutions of different dilutions, and number of bacteria.

	Percentage of rotted carrot slices after 48 hours incubation				No. of bacteria per gram of soil ($\times 10^{-6}$)
Order of dilution	10^{-1}	10^{-2}	10^{-3}	10^{-4}	
Experiment 1 : 16th October, 1952					
Rhizosphere soil, inoculated with *E. aroideae*	60	20	20	0	172.0
Control soil	10	10	0	0	0.1
Rhizosphere soil, non-inoculated	20	0	10	0	13.0
Control soil	10	10	0	0	0.09
Experiment 2 : 26th October, 1952					
Rhizosphere soil, inoculated with *E. aroideae*	70	60	40	40	382.0
Control soil	20	10	30	0	0.3
Rhizosphere soil, non-inoculated	10	30	10	0	47.0
Control soil	20	10	10	0	0.3

from late October by heating.

The microbial number in rhizosphere soil was estimated by the usual plate-count method on Drigalski's medium and the activity of the soft rot bacteria was evaluated with the carrot-slice method[11]. The results obtained are shown in Table 4.

The figures in Table 4 evidently tell us that relative incidence of soft-rot organisms in rhizosphere soil, which had inoculated with *E. aroideae*, was much higher than that in the non-inoculated. Analogous tendency was also found in the number of bacterial colonies appearing on Drigalski's medium. Bacterial number in inoculated rhizosphere soil was estimated to be ten times as much as that in non-inoculated rhizosphere soil. Among the colonies appearing on Drigalski's medium plated with the soil solution of inoculated rhizosphere many transparent colonies with yellow nucleus were observed. Therefore this difference may arise mainly from the inoculation of *E. aroideae*. It seems that the rhizosphere of the chinese cabbage may provide favorable conditions for the flourishing of the soft-rot organisms.

III. Microscopical observation of rhizosphere

1. Experimental methods

To observe the feature of bacterial growth on plant roots, Linford (1942)[9] devised a staining procedure with lactophenol acidfuchsin. Though an excellent method it may not serve to observe bacterial features both in the rhizosphere soil and in the soil apart from rhizosphere. The authors employed Cholodny's contact slide method after Starkey (1938)[10]. Using this method the features of the microflora in rhizosphere can be easily observed under the microscope.

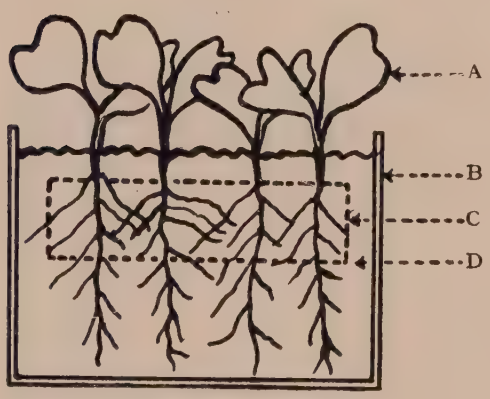

Fig. 1.
A. Seedlings of chinese cabbage.
B. Vessel.
C. Microscopic slide
D. Soil.

A sterilized microsopic slide or glass plate was inserted into the soil in a pot (Fig. 1). Seeds of the chinese cabbage, preliminarily sterilized with 0.1 per cent solution of mercuric chloride for 30 minutes and washed with sterilized water, were sown on one side of the slide or plate. The pots were kept in the experimental room or in the green house. As the plant develops the roots may growth along one side of the slide. After the slide was taken from the soil, the larger soil particles were removed and dried, then stained with 1 per

cent. phenolic rose bengal or with 1 per cent phenolic erythrosine for 10 minutes. During staining the slides were kept over the boiling water-bath. After washing, the preparates were examined under the microsope.

Sandy loam soil from the experimental field of our institute was used after passing through a 2 mm-mesh screen. Sterilization was performed under the pressure of 15 pounds per square inch for 5–6 hours.

Two soft-rot organisms, viz., *Erwinia aroideae* and *Bacillus polymyxa* were used in this investigation : the former was identified by Dr. H. Muko and the latter was isolated from the field soil of the Tohoku Agricultural Experiment Station at Morioka[1] and identified by the present authors.

2. Experimental results

(i) Colony formation of *E. aroideae* in rhizosphere of the chinese cabbage

Bacterial cells, collected from one agar slant and suspended in 5 cc of sterilized water, were applied with an atmoizer to a glass pot containing 300 grams of sterilized soil. To secure uniform dispersion in the soil of the organisms, inoculated soil was thoroughly mixed, and, if necessary, sterilized water was added to hold moisture at about 60 per cent of water holding capacity of the soil. The slide was taken from the soil 4–7 days after sowing and then examined under the microscope.

As shown in the photomicrographs (A, B, and C), bacterial colonies formed around the roots and root-hairs could be observed by low power magnification (×180). The fact that carrot-slices inoculated with the root-pieces rapidly rotted within 24 hours incubation and no bacterial colonies were recognized around the roots in the non-inoculated soil, lead to the conclusion that these colonies were of *E. aroideae*.

The colonies formed around the roots were classified into three types : (1) colonies composed of a thin layer of bacterial cells (photomicrograph A) ; (2) sheath-like colonies (B) ; and (3) aggregated colonies (C). However, all the roots examined were not always colonized with *E. aroideae*. Comparatively larger colonies were observed, as a whole, on the roots near the soil surface. The number of colonies decreased with the increasing depth of the soil.

Bacteria observed in the soil apart from the root were isolated scatteringly with each other, comprising a single cell or paired cells.

(ii) Colony of *Bacillus polymyxa*

It had been reported previously[1] that *Bacillus polymyxa*, isolated from the soil, has an ability to rot the chinese cabbage and carrot. To compare the nature of the colonies of *E. aroideae*, *B. polymyxa* was inoculated according to the method mentioned above. As observed in the photomicrographs D and E, the latter could also colonize around the root hairs of the chinese cabbage.

(iii) Mixed inoculation of *E. aroideae* and *B. polymyxa*

The authors isolated 5 strains of *B. polymyxa* (Praz.) Migula, all of which have

an antibiotic effect to *E. aroideae* in vitro. Five days' culture plate of *B. polymyxa* was punched out with a cork borer (9 mm in diameter) and placed on bouillon agar, previously mixed with *E. aroideae*. When incubated at 30°C for 24 hours, a distinct growth-inhibiting zone (about 30 mm in diameter) to the latter species was formed. To ascertain whether a microbial antagonism may occur in rhizosphere mixed inoculation experiments were undertaken. The cells of both species could be easily distinguished from each other by microscopic examination, as the former is a short rod (1.2–2.8 × 0.4–1.1 μ) and the latter a long rod (2.9–4.4 × 0.7–1.3 μ).

In rhizosphere no microbial antagonism could be observed between them. They were found to grow in adjacent position of root (photomicrograph G) and even side by side (photo. F). This fact indicates that the antagonism observed in vitro does not necessarily occur in soil or rhizosphere ; in other words the fact that an organism produces an antibiotic substance in culture media is no evidence that it is capable of doing so in the soil.

(iv) Microscopic observations of rhizosphere of the chinese cabbage grown in non-sterilized soil

The above three experiments were all performed with sterilized soil. In this experiment, however, microbial behavior was exmained on non-sterilized soil with or without inoculation by the causal organisms. Bacterial cells to be inoculated were collected from two agar slant cultures. After washing with sterilized water, they were suspended in 5 cc of sterilized water and applied to each pot. Bacterial suspension was inoculated with an atomizer and the soil was strirred thoroughly. For each pot 3 grams of ammonium sulphate, 2 grams of calcium superphosphate and 1 gram of potassium chloride were given. Glass plates were inserted vertically into the soil prior to sowing and removed periodically for exmaination of rhizosphere. The sterilized seeds were sown on September 1st, 1952. Until the first observation 6 days after sowing, sterilized water was given for maintenance of soil moisture and thereafter tap water was given.

a : Comparison of the number of large colonies formed in rhizosphere. Various bacterial forms were found in rhizosphere. Among them the predominating form was the short rod and it often formed large colonies on the root hairs (photo. H and I). The large colony assigned here means a colony which has an area occupying the whole microscopic field (magnification : 180 ×) or more. The number of them formed on the root surface of the chinese cabbage, grown on the non-sterilized soil with or without inoculation of *E. aroideae*. was counted under the microscope.

Glass slides were removed from the soil and examined at three periods, viz., early September, middle October, and from late October to early September. Three slides were observed for every examination. The results are shown in Table 5.

Table 5. Number of large colonies observed in the rhizosphere of the chinese cabbage.

Date of sampling	Inoculated soil Depth from soil surface (cm)				Non-inoculated soil Depth from soil surface (cm)			
	0–3	3–6	6–10	Total	0–3	3–6	6–10	Total
Sept. 6	25	10	0	35	9	0	0	9
" 7	3	18	2	23	13	4	1	18
" 8	15	10	7	32	3	1	0	4
Total	43	38	9	90	25	5	1	31
Oct. 14	13	4	1	18	6	5	1	12
" 15	7	3	1	11	2	2	1	5
" 16	8	1	0	9	6	2	1	9
Total	28	8	2	38	14	9	3	26
Oct. 22	12	26	16	54	9	7	2	18
Nov. 5	25	18	40	83	8	18	7	33
" 8	27	42	23	92	18	23	20	61
Total	64	86	79	229	35	48	29	112

The results were examined by analysis of variance. The number of colonies formed on the roots of the chinese cabbage, grown on the inoculated soil, was greater than that without inoculation, except for the second examination. The difference may arise from inoculation of the causal organisms, and also corresponds to the results obtained in the experiment on the activity of soft-rot bacteria in the soil described in chapter II. Large number of colonies were mainly formed near the soil surface (0–3 cm), but in the third examination it was found in the second layer (3–6 cm).

b : Microscopical observations of rhizosphere. In the soil apart from plant roots, bacteria were found to exist separately in one or two cells, generally small and coccoid-form, or to form a small colony. Most of the colonies (90 %) around the roots mainly composed of the short-rod and sometimes of coccoid bacteria, while long rods were seldom found. On some roots large colonies, as shown in photomicrographs J and H, were observed and they generally occured near the soil surface. No difference could be observed morphologically among the bacterial cells colonized on the root in the soil with or without inoculation.

Actinomycetes, in both conidial and filamentous forms, appeared abundantly in rhizosphere, and bacterial cells were rarely observed in the locus occupied with actinomycetes. As they were well stained in dark red color, they could be easily distinguished from fungous mycelia. However, as Starkey (1938)[10] stated, "it was impossible to tell whether certain rod shaped cells were bacteria or conidia of actinomycetes."

Fungous filaments were also found on many slides burried in both treated soils. Most of them seemed to belong to the genus *Penicillium* and to the genera of *Mucoraceae*. Fungous filaments were sometimes found in the rhizosphere of

the chinese cabbage, but it is not certain whethere they are capable of attacking its roots. Aggregation of bacterial cells occurred around the mycelia, especially on the parts of septation.

IV. Summary

The present investigation was made on the development of the soft rot organisms in the rhizosphere of the chinese cabbage grown in infested soil by means of the usual plate-count method and of direct microscopic observation.

The bacterial population in rhizosphere was always more abundant than in the soil apart from plant roots. Bacterial number in rhizosphere seemed to increase with the advancing growth-stages of the host plant. Most of them were short rods or coccoids, and long rods were seldom found. Among them the existence of the soft-rot organisms were demonstrated by the carrot-slice method or by direct inoculation test on healthy petioles of the host plant, and by identification of the reisolates from the rotted tissues. Direct microscopic observation of rhizosphere also showed that *E. aroideae* is capable of growing on the root surface of the chinese cabbage.

Bacillus polymyxa, being capable of inducing soft-rot under a laboratory condition, was also found to colonize on the root surface of the host plant. Although it could inhibit the growth of *E. aroideae*, on the culture media no antagonistic effect could be recognized in rhizosphere.

Large bacterial colonies were observed on the root surface of the chinese cabbage grown on non-sterilized soil with or without inoculation of *E. aroideae*. They were found more abundantly in the inoculated rhizosphere and seemed to increase with advancing growth-stages of the host plant. They decreased with the increasing depth from soil surface.

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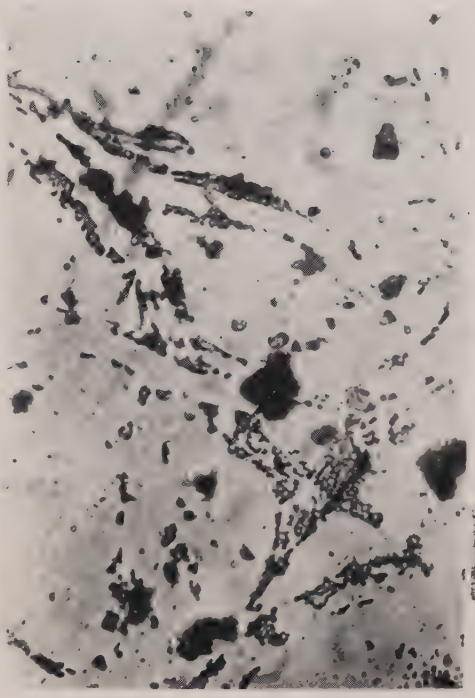
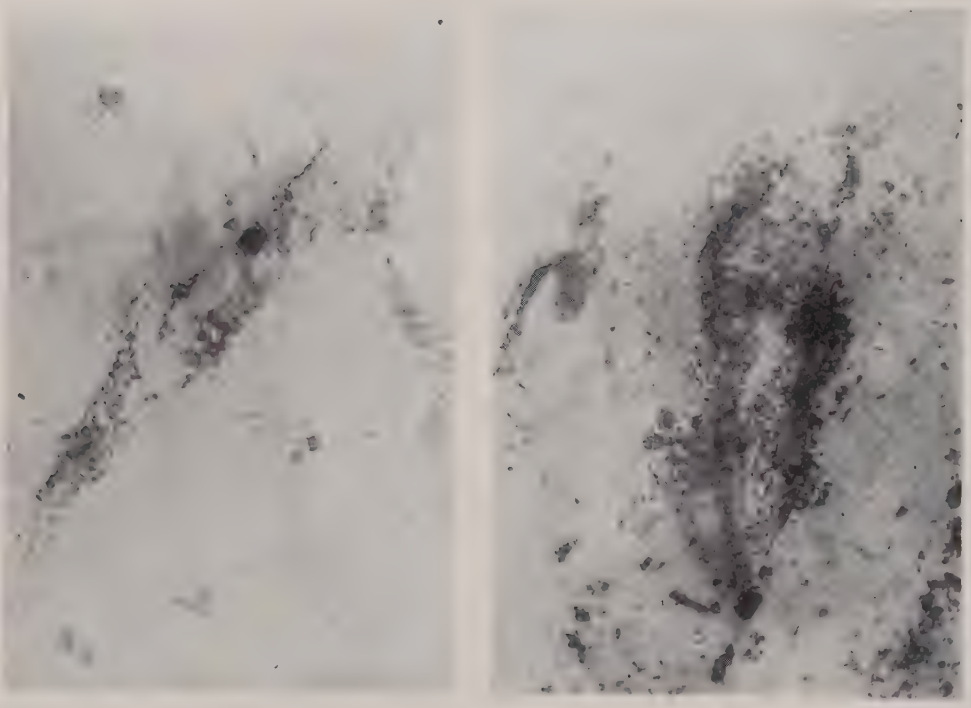
A



B

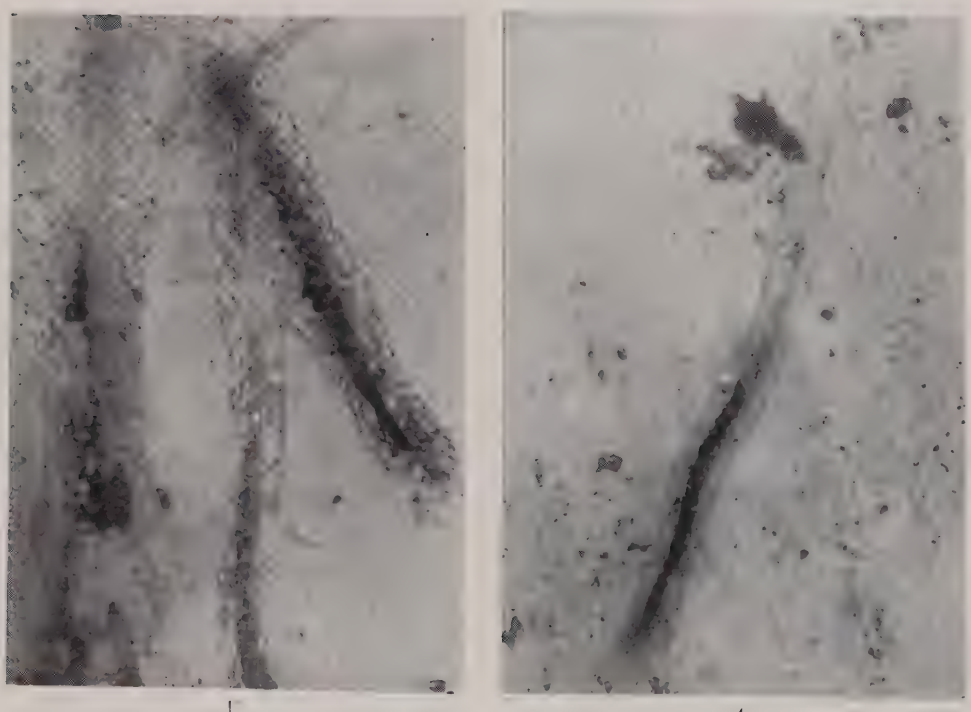
C

A, B, and C ; Colonies of *E. aroideae* (Towns.) Holl. observed around the roots of chinese cabbage. 360 ×.



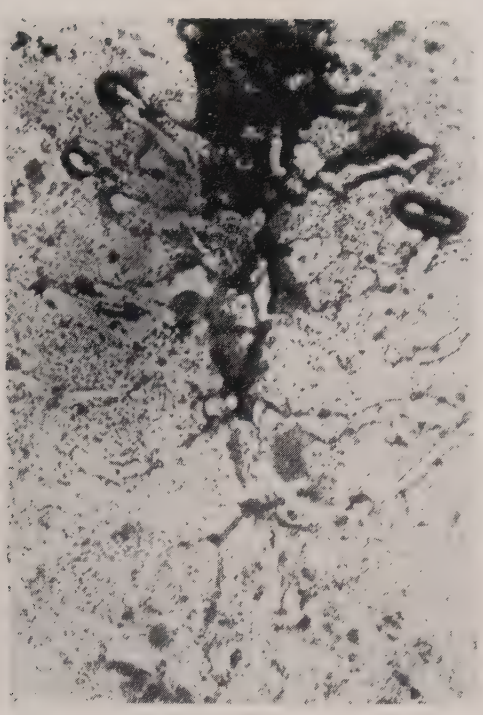
D E

D and E ; Colonies of *Bacillus polymyxa* (praz.) Migula observed around the roots of chinese cabbage. 450 ×.



F G

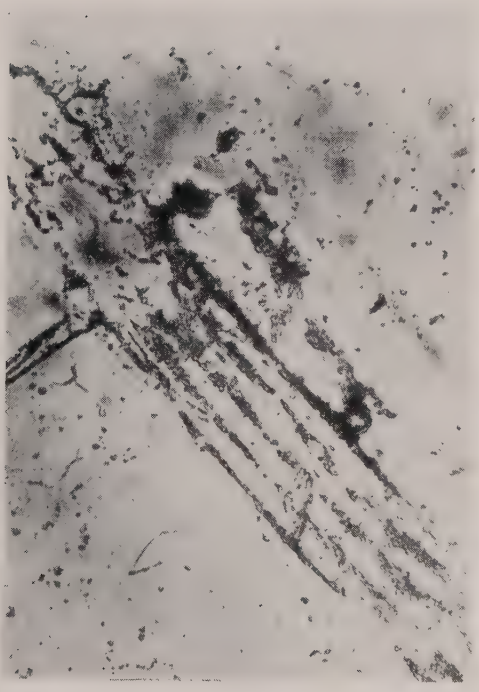
F and G ; Mix colonies of *E. aroideae* and *B. polymyxa* observed around the roots of chinese cabbage. 450 ×.



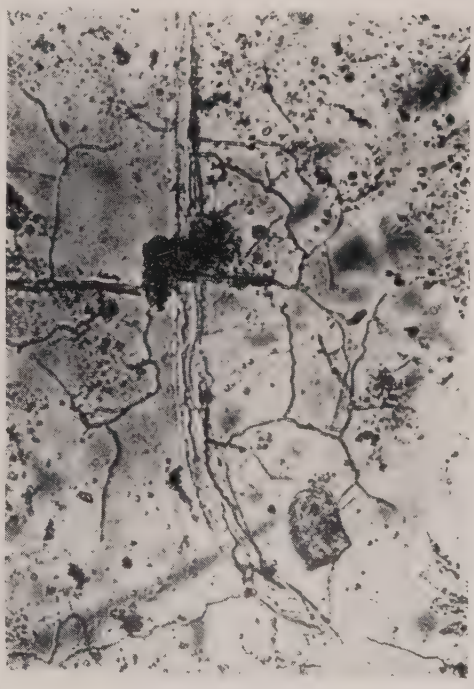
H

I

H, I, and J ; Colonies of soil bacteria observed around the roots of chinese cabbage. H 180× I and J 360 ×.



J



K

K ; Colonies of actinomycetes observed around the roots of chinese cabbage. 180 ×.

Economic Character of the Rice-Raising Agriculture*

Shigemitsu SUNAGA

(Received February 10, 1954)

I

The opinion that the single crop farming is a feudalistic agriculture and the rotation farming a modern one seems to be very widely accepted by most of those who are concerned with agriculture in post-war Japan. This, as I understand, is a sort of antithetical way of thinking which stresses the weakness involved in the economic character particularly of the rice-raising agriculture of this country. But the students of the agricultural economics, logical as they are, in using this expression, ought to be clear about the reasons why the rice-raising agriculture can be said in that way. And they would be so only if they could objectively determine the economic nature of the rice-raising agriculture by comparing this system of farming of ours with the general process of development of agriculture in the history of the world.

The technical basis for maintenance of the agriculture, which in turn constituted the economic basis for the feudal society of Europe, was the so-called three-field system. This system of farming became difficult to be maintained when commercial economy rapidly penetrated into the farming society to the point that it deprived this farming system of its general ground for existence, with progress of commercialization of agricultural products. The commercialization of agricultural products was encouraged partly by the demand of the developing manufacturing industry in urban areas for agricutural products as raw materials, but more generally by the demand for food to feed the industrial population concentrated in such urban areas, and led to general abandonment of the three-field system of farming. The industrial labor, as it is, unlike idyllic farm labor, involves mental as well as physical strain peculiar to modern labor, requires high

* The 107th report of the Institute for Agricultural Research, Tohoku University (1953)

class protein food. Demand for meats developed quite naturally as the cities grew. Livestock on the pasture, which had played a part in the three-field system, was driven to market as slaughter stock. The farm land, which had been fertilized only by grazing animals, lost the means of fertilization now, resulting in not only reduced yield of crops but also reduced area of cultivate land owing to loss of animal power necessary for various farming operations. Thus, the feudalistic system of farming inevitably collapsed with development of industry in cities and subsequent penetration of commercial economy into the rural society.

The modern system of farming, newly developed while the structure of the feudalistic agriculture was braeking down, was a kind of rotation farming called Norfolk system. It differed from the three-field system in such ways as the livestock, which had been grazed on common pastures, was now fed in barn while feed crops were grown and havrested, and, on the other hand, the stable manure produced by keeping livestock in barns was applied to land for fertilization, and also as the characteristics of particular crops were made use of to save manure and a number of different crops were combined systematically to be grown on different divisions of the farm so that serious damage by diseases and insects could be prevented and labor could be saved. One will be wrong if one thinks that this system of farming was born merely as a technical idea just out of studies at desk or ideal thinking. It was a farming system developed to meet the demand of the new commercial economy while the old relations of production broke down. But still, it was shaped in such a way as it was as a necessity of the days when the technological as well as economic progress of the society had not reached yet the stage in which chemical fertilizers or agricultural chemicals could be produced on any commercial scale. We should therefore remember the historical character attached to this system that it came in to existence to commercialize agricultural products, but still in such a stage of progress of society as mentioned above.

Indeed, it came into the world to modernize agriculture. However, it was characterized historically by the technological immaturity of the early stage of the capitalism in which it was developed. It was not the system, for example, which perfectly enabled production of commercial crops alone. There had to be grown feed crops, too, and fertilizing crops and still other crops for use on own farms. A number of different crops had to be grown alternately in order to even out risk of damages by diseases, insects, or any other causes. From the viewpoint of profitability of commercial crop production, as much expansion as possible of production of crops fittest for the natural conditions of the farm will be natural and desirable. In the rotation system of farming, it was impossible to cultivate a few particular crops alone, however suitable and profitable crops they might be. In the feudalistic self-sufficient agriculture, such crops as necessary for farmer's living and production had to be grown on own farm even when they were not

suitable crops, and, therefore, the number of crops grown on a farm was extremely large and was affected only by the relationship between farmer's own desire and natural conditions of the farm. Such crops tended to be reduced to a small number in the modern rotation system for technical reasons, but were still not simplified to a single crop most profitable.

With development of science and technology in the society and accumulation of capital on farms, enabling introduction of new scientific and technological findings, the agriculture grew more definitely capitalistic. It became a production overwhelmingly for market. In order that this was made posible, division of labor in society developed in agriculture, too. Farmers came to concentrate production efforst in different single crops for market ; some of them in dairying, some others in feed crops, and still others in grapes or apples, etc. Even the potato, which ordinarily is not advisalbe for successive plantation, might be taken up as the only crop in a capitalistic farm management. Of course, this shift toward the single crop system is based on the modern rationalism, and firm establishment of technological basis is important for its successful realization. At any rate, however, for the rotation farming to progress as a commercial one, it is necessary that the crops grown in the rotation system should be reduced to a small number, leading only most profitable crops, and finally to a single crop. In this sense, the rotation system was a technique developed on the ruin of the three-field system and, at the same time, provided a nursery for the modern single crop system, which was to develop with progress of modernization of agriculture. Thus, the modern single crop farming is the ultimate form the commercial agriculture will take, and can be understood as the farming system which grew out of the very rotation system as the latter developed. Therefore, the single crop system in its proper sense is not only non-feudalistic at all but actually the most progressive modern system of farming.

II

What socio-economic peculiarities actually characterize the rice-raising agriculture of this country while it is similarly termed as a single crop farming ? We must determine the position for it to be placed by setting it against the proper form of historical development of the agriculture of the world.

It is not known how the rice became the most important crop of our agriculture. Partly for racial reasons perhaps, and partly because our agriculture depended upon the South-Asian type of climate characterized by high temperature and moisture in summer time, perhaps. It is true that the rice has been grown from very old times and been the basic food for the people. The feudal society of this country was founded on this fact, and the feudalistic tribute consisted primarily of the rice. One's power in the feudal society of this country, it can be said, was determined by how much rice one could have in control. Therefore, the feudal

lords always endeavored to have more rice in control in the form of tribute. For this purpose, they tried to maintain the highest possible rate of tribute, allowing a sheer survival of farmers as producers. There, of course, was a certain limit in this direction, and the land for production of rice, vegetables, fuel wood, clothing, lamp oil, etc. to maintain the minimum standard of living of the self-sufficient farmers was needed. The limitation which the feudal lords had to face first when they tried to establish economic basis for their power was the self-sufficiency of farmers. The feudal lords of this country thus endeavored for reclamation of waste land and have recorded here and there in a page of history construction of a number of irrigation routes, reservoir, and so forth, which would be accepted as wonderful works even nowadays. In this country, desire for rice of the feudal lords was earnest because the rice controlled so essential a part of the economy that the economy of our feudal society has often been referred to as rice-economy. The farmers, however, who actually produced rice, had very little rice to sell because of the high rate of the rice tribute and large consumption of rice on own farms, and, even if they had any, the market was too limited for them to be able to sell it actually. It was the feudal lords who had the rice to sell. They had to sell the rice they collected as tribute to the non-producers of rice, such as merchants and handicraftsmen who had come to live in a large mass in castle-town and other places of political importance by that time. Generally, the farmers, producers of the rice, being self-sufficient both in living and production, had to raise a variey of other necessary crops themselves to meet their own needs, and could not be sellers of the rice. The feudal lords, non-producers of the rice, were the sellers of the rice actually. Thus, ironical enough is that the feudal lords desired the single crop farming of the rice on one hand, but the system of their control of farmers, on the other hand, required maintenace of the feudalistic self-sufficiency of farmers.

The latter part of the feudal age already witnessed formation of the landlord class to some extent with economic break-down of a part of owner-farmers. It was, however, in Meiji era that the landlords first came to constitute a controlling class of the farming society. As the laws of the Meiji Government provided for cash payment of the land tax and recognized property right of the farmers on their land, those farmers, as the masters of the rice they produced, had to sell it themselves in order to pay the land tax with the money obtained through such sale. Also in cities, commercialization of the rice progressed in the developing capitalistic economy. Besides cash payment of taxes, cash expenses for living increased rapidly, resulting in economic deadlock for farmers in a short period of time, who depended upon the techniques of production of the feudal age still in this scoiety of commercial economy. They had no choice but to sell rice even by lowering the standard of their own living in order to meet the ever increasing need for money. But their economy based on raising of the rice, one of most uncertain

crops, drove them in the capitalistic system of economy to such an extreme poverty that they often could not maintain the land they had acquired. The landlords as a social class rapidly grew to become the ruler of the farming society toward around 1880.

Sale of rice was a big job for the landlords because they, though not farming themselves, collected the rice rent. In the first part of Meiji era, many *sake*-dealers and usurers concentrated large areas of land in their hands, taking advantage of their dealing relations and, as they collected a considerable quantity of rice as land rent on one hand and knew profitability of rice dealing on the other hand, came in many cases to carry on the rice dealing besides their original business. Even the landlords who did not become rice-dealers presented themselves highly businessmanlike, building storehouses for the rice to take advantage of a higher price at a later time of the year in marketing it.

Thus, in place of the feudal lords in the feudal age, the landlords now became the sellers of the rice. The difference, however, which existed between the feudal lords and landlords in the attitude toward the single crop farming lies in the fact that the latter could push straight forward the shift toward the raising of rice as the only crop while the former had to concede for the minimum daily necessities of the farmers. Because the feudal lord had to take into account the living of farmers, however much increase of rice tribute he might desire, shift toward the single crop farming of the rice was limited by the minimum necessities of the self-sufficient farmers. On the other hand, the landlord had his tenants use his land just by contract for such use, and the living of the tenants was their own problems as a rule. The landlord stood at liberty of making either paddy fields or upland fields on his land, or, even having nobody cultivate his land, leaving just as a waste land. Only economic reasons could affect his decision. He might convert all his upland fields and waste lands into paddy fields if he believed the rice could sell more advantageously. Thus, there had to be considered only the relative economic advantage on the part of the landlord himself, and no consideration had to be given to the living of the tenant farmers. The landlords made up a substantial driving power toward the single crop farming. The readjustment of arable lands, reclamation of waste lands, and conversion of ponds, swamps, and dried river-beds, and even upland fields under use into paddy fields, widely carried out after middle-Meiji era will well illustrate the process of such shift toward the single crop system of farming, which was supported by the landlord class as commercialization of the rice progressed. It is sure that such readjustment and reclamation works could not be carried out by the landlords alone. There was needed cooperation of owner-farmers. Still, initiative was held by the landlords.

In the light of the above facts, it is obvious that the rice-raising agriculture as a single crop farming was supported by the feudal lords in the feudal age and by the landlords in and after the Mejii era rather than by free choice of farmers

themselves as producers of the rice. This is entirely different from the situation which existed in the Western countries where the single crop system grew, on the right-crop-on-the-right-farm principle, out of the rotation farming which replaced the feudal system of the agriculture. Shift toward the single crop system was made by the very farmers who actually did farming there, and by the feudal lords and landlords here. This is an essential difference. We must say, therefore, that this fact that the rice-raising agriculture can not be understood to be of any modern nature is strongly reflected in its economic characteristics.

III

As described in the last foregoing section, the rice-rasing agriculture has presented itself as a small scale farming peculiar to Japan, and is a single crop system of farming which has failed even to pass through the stage of rotation system of farming. It involves the influence of the commercial economy but is essentially not equipped with the kind of system of management enabling commercial production. Production both for market and for household consumption are included in the same single management, and, moreover, the latter is generally more essential while the former is added as something economically extra. Therefore, the household consumption purposes predominate the management so that various factors in it do not necessarily function or are utilized as capital.

Small scale of management does not always mean a selfsufficient farimng, of course. The greenhouses or horticultural farms on outskirts of cities, for example, are not self-sufficient though small. Generally, however, small farmers are self-sufficient in most cases, and self-sufficient farmers can live on a relatively small area of land. Since higher degree of self-sufficiency means, from another viewpoint, less exposure to influence of the commercial economy, the rice-raising farmers, being highly self-sufficient, rarely expose their staple food to the influence of the commercial economy. We can say, therefore, that it is those areas relatively remote from the centers of commercial economy where rice farmers are densely distributed. It is possibly for this reason that Hokuriku and Tohoku districts, for example, still have a larger number of such farmers than other parts of the country.

Not only economic but also natural conditions which are required for this particular crop, rice, tend to limit this kind of farming to certain areas. That is, the rice requires much water, and such land as is flat and has easy access to irrigation moat is generally more adivsable for rice production. But, if the rice is to be raised as the only crop, rate of utilization of land is under limitation by the climate and natural features of the land concrened. Hokuriku and Tohoku districts have a long winter, an low temperature and deep snow prevented raising of any other crop after harvesting rice until recent years. Morse correctly, though it was not absolutely impossible, it was feared that double cropping might reduce

the yield of the rice as the main crop and endanger not only collection of land-rent but also security of food for farmers themselves. For this reason, the rice-raising agriculture as a single crop system of farming developed in flat land areas of the cold sections of the country far from the centers of the commercial economy.

Such social and natural conditions tend, as a matter of course, to make such farms to be self-sufficient and non-commercial in their economic character. The rice-raising agriculture has been a system of farm mangement closely related to economic break-down of farmers even without the effect of the rice collection system as a political factor. In the central parts of the rice areas, landlords owning several hundred *cho* of land were cropping up while the number of tenant farmers was increasing before the recent Land Reform. It was a common phenomenon that tenant farmers proper reached 30 to 40 per cent of all the farmers in a village of such areas. Adding the numbers of owner-tenant and tenant- owner farmers to that figure, around 90 per cent of the total number of farmers rented more or less land owned by others, and the pure owner-farmers accounted only for less than 20 per cent of all the farmers. The Land Reform effected a drastic change in the class construction of such rice areas, where owner-farmer class had been extremely weak, to such an extent that owner-farmers represented 80 to 90% of all and the hundred percent tenant farmers disappeared nearly totally. In spite of this change in class construction, however, very little qualitative change took place in the management system of the rice farm.

The reason for the failure of qualitative change in the management of the rice farm lies in the fact that the smallness of farm size and self-sufficiency of the farm economy could still not be eliminated. This was because no change could occur to the economic structure of production on the farm, although the landlord class was eliminated. The inflationary trend of the post-war economy boosted nominal cash income of the farmer, but the squeeze between the price he received and that he paid became serious as the time passed by to the point that the nominal increase of cash income revealed its real effects, brinigng about once again economic hardships of such rice farmers.

We shall have a look at their actual ceonomic situation for a moment. The following is the data collected in the survey the author conducted in 1949 on some groups of rice farms in Miyagi prefecture for study of the economic situation on those farms during the year 1948. (For details, please refer to *Rice-Raising Agriculture in Miyagi Prefecture*, Agricultural Administration Bureau, Ministry of Agriculture and Forestry, 1949). Taking an example from Nango village which had the highest percentage of paddy field among all five villages surveyed, the agricultural income, except farm consumption of the things obtained from own farm, of the average farm of the community concerned was 145,794 *yen*, while the expenditure for the farm management totalled 68,699 *yen*. And the household expenditure, except consumption of own products, was 70,043 *yen*. Thus, the

combined expenditure for farm management and household was 138,742 *yen*, leaving a favorable balance of 7,052 *yen*. It should be noted, however, that this favorable balance was an average figure, and that it can not have occurred to all the classes of farms. In another village surveyed, an unfavorable balance of the average farm of 15,701 *yen* was observed. As far as Nango village is concerned, however, the figures show that the pure agricultural income alone could well cover both farm management and household expenses. Besides, an average farm of the community had an income of 21,871 *yen* through black marketing of rice. Consequently, the total pure agricultural income exceeding expenses added up to 28,923 *yen* actually.

In addition to the agricultural income, the average farm had a non-managing income of 10,224 *yen*, while there was a new debt of 7,467 *yen*.

As the average figures show, although there occurred a new debt, the surplaus far exceeded it. It appears from this that the rice farmers were doing well in this community. If we examine the data more closely, however, we find a marked variation in the balance sheet among different classes of farmers. It was only the farmers cultivating three *cho* or more of land who could live on the agricultural income alone. The 2–3 *cho* class farmers had side jobs in many cases in one way or another. Viewed from the standpoint of income composition, the top class farmers had some income from sale of vegetables, fruits, or livestock in addition to rice, though low in percentage of the total, while, as shown by the data, the sale of rice was the one and only sourcre of agricultural income for the farmers of the less-than-two-*cho* classes, except for one special case. The non-managing income can be distinguished into two different groups by the source : one is the salaries for the 2–3 *cho* class farmers and the other such incomes as from short-distance transportation with hores-carts or from various kinds of day labor for the less-than-one-and-half-*cho* classes. The middle farmers cultivating one and a half to two *cho*, representing a great majority, had no non-managing income. As for the cash receipt from exchange transaction, withdrawal from sadings was observed for all classes of farmers with the exception of under-0.5–*cho* farmers. It is obvious from these data that only the farmer with a farm of three *cho* or more could live on his agricultural income alone, and the farmers with smaller farms had to have a non-managing income to supplement it.

This, without any further explanation, reveals the economic character of the farm raising rice as the only crop. It is shown that the single crop farmers need a farm of larger size and also that there is possiblity for a part of them to secure higher economic stability by introducing some upland field crops or fruit-trees.

The farmers with a relatively large farms of two to three *cho* had a non-managing income as salaries besides the agricultural income to maintain farm management and household. The fact that there was an income other than the agricultural income should be noted after all. The same thing is applicable to

the less-than-1.5–*cho* class farmers, too, but these small farmers, like the two-*cho*-or-more classes, had an agricultural income accounting for about half of the total income. For the under-0.5–*cho* class, the non-managing income accounted for more than half of the total. Generally, the class for which the agricultural income occupied the largest percentage was 1.5–2–*cho* farmers, who had only little non-managing income and cash receipts from exchange transaction, while the agricultural income represented 76.2% of the total income. These farms are so simplified in the type of farm management that the agricultural income consisted exclusively of sale of rice and, moreover, there was no non-managing income at all. Consequently, the farmers of this class had such cash receipts from exchange transaction as withdrawal of savings, borrowed money, etc. to fill remaining 23.8% of the total income. The name of "most typical rice farmers" may be applied to the middle farmers of 1.5–2–*cho* class, the largest group in number as a whole, in the case of Nango village. Of course, it is not true in all rice arcas that the middle calss between the richest and poorest farmers consist of farmers with farms of this size ; maybe 2–2.5 *cho* class here, maybe 1–1.5 *cho* class there. At any rate, however, there is usually a middle class representing a majority in such farming areas, for which the rice is the one and only source of income and there is no such other items of income as upland field crops, vegetables, fruits, livestock, sericulture, etc., or non-managing income. The farmers with farms smaller than this are usually part-time farmers, for whom the rice is the only source of the agricultural income but the non-managing income becomes higher in percentage of the total income as the size of farm decreases.

This fact suggests another problem. Stability of farm management, to say nothing of the standard of living, can not be secured in the rice areas unless an extra income from subsidiary jobs could be earned in one way or antoher. For a farm of 3 *cho* or more, stability can be secured through diversification of farming. Stability may be secured by earning salaries and wages as a non-managing income for a farm between two and three *cho*. An under-1.5–*cho* class farmer can maintain his economic basis only with an income from off-farm labor of semi-laboror type, or rather, he is making up for the unstable income from his labor by the self-sufficiency of food.

The middle class rice farmers, as far as the balance sheet is concerned, appear to maintain a well balanced farm economy. Actually, however, they are constantly exposed to fluctuation of the prices, especially of the rice, making them an unstable middle class, keeping them in black this year and throwing them into red next year. The farmers of this class take the largest percentage in number in the rice areas. The economic problem of the rice areas is the one of poverty prevailing among so many of those farmers who compose the middle to lower classes, not the one concerning the middle to richer farmers. In Nango village, the farmers of this middle class counted 729, or 62 % of the total.

Such economic peculiarities of the farm management in the rice area as described above is naturally reflected in the size of income and living expenditure as well. Nango village is one of the economically more favorable in this rice area. Still, our data show that the gross agricultural inocme per *tan* was approximately 8,871 *yen*, exclusive of farm consumption of own products, while the farmers of the vegetable area around the city of Ishinomaki received 22,964 *yen* as the gross agricultural income per *tan* in the same year. Including non-managing income and cash receipts from exchange transaction, the gross income was 17,293 *yen* per *tan* for a rice farmer, but 33,411 *yen* for a vegetable farmer. In every respect, the former had far less cash income. It can be said that he is making both ends meet only by lowering his standard of living. The farm household expenditure per capita in Nango village for that year was 9,053 *yen*, one of the highest levels observed in the rice areas. This is the net household expenditure exclusive of consumption of own products. We had an example of a lower level of living standard in the rice area, as revealed by the survey, of 4,662 *yen*. The vegetable area, on the other hand, showed a per capita expenditure of 13,221 *yen* during the same year. Briefly, that the short income is made up for by lowered standard of living to maintain farm management, is an essential character of the economy of the farmers of the rice area.

Summary

An essential determining factor for the ceonomic weakness of the rice-raising agriculture as a single crop agriculture is the fact that this is never a single crop farming in a modern sense. It is not a single crop system which has grown out of the modern rotation system of farming, but the one which was required to be maintained in that way as the economic basis for the power of the feudal lords and was, later on, encouraged for the benefit of the landlords. Thus, an essential problem lies in the fact that this type of farming is not the one which has been developed at the own interest of the farming people. Moreover, self-sufficiency and smalleness of the farm management have persisted as the basic causes preventing utilization of factors in the farm management in the way of a modern capital. Nevertheless, inside such agriculture, division of classes among farmers has progressed. A farm larger than a certain point in size can nearly secure stability, if not prosperity, of the living of the farm family through farming alone, while a farm smaller than a certain minimum size can make only a poor farmer with an unstable living standard. The farmers of the class between these extremes are single crop farmers in a real sense of the single crop farming area. These farmers, being a majority group, stand in the center of the problems of economic difficulties of the rice area. These difficulties may be met by taking up subsidiary jobs, or by much lowering the standard of living after all.

As will be clear from the above brief summary, for improvement of the farm

management of the rice area, it is important, if the size of each farm can not be increased rapidly, to encourage the rotation system, at the own initiative and for the benefit of the farmers, to the basic goal that the farm management is capable to adapt itself to the commercial economy. The Govermnent measures should be focused on the typical rice farmers who make up the middle calss. Diversification of farming system for production of a variety of commercial crops, finding out possiblities of rotation farming, double cropping, or stock-raising on the middle class farms in the first place, will be recommended because the top class farmers have actually found their way along this line even in the rice area. What new techniques are to be introduced will have to be decided by the farmers themselves. At any rate, however, how to obtain capital for this group of farmers who are short of capital and how to make such capital function most efficiently are entirely problems of the future.

From the viewpoint of use of capital, the rice farm is a one where the capital can be turned over very slowly and where it is held without functioning just like assets, or even like heirloom.

Recent Tendency in Transfer of Agricultural Land after Land Reform in Japan

Actual Conditions in Tohoku Region*

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(Received March 1, 1954)

I. Introduction

Agriculture in Japan before the land reform may briefly be characterized by two features. First, each farmer keeps his land on a very small scale and its management is very unscientific. Second, the arable land is mostly owned by the landowner who charges a high rate of rent in the form of farm crops. These two features have, by no means, arisen from two different circumstances. They are nothing more than two expressions of two points of viw on the characteristic structure of the process of reproduction in arable land in Japan, one from the management and the other from the ownership of farm. However, views are not unanimous as to how these two characteristic features have been formed, either logically or historically out of various social and economic conditions.

The land reform effected this time which aimed at a complete clearance of such characteristic features as exist in our agriculture was epoch-making in our farm land system, and there seems to be no great divergence of opinion on it. As to its significance and valuation of its actual results, the opinions are divided, and, as everyone knows, there were great controversies not only in Japan, but also in foreign countries, especially among agricultural economists in America. A unanimous conclusion has not yet been established. It seems, however, that these contraversies were not carried and on a complete examination of the structure of the process of farm reproduction in Japan from two sides, management and ownership of arable land. In view of the fact that a large number of independent farmers created by the land reform law has fallen back to their former position and that such a change is on the increase year after year, it seems

* The 108th report of the Institute for Agricultural Research, Tohoku University (1953)

necessary that the land reform should be examined again in its present significance and in its achievement. It was this in mind that we carried out an investigation on the actual state of transfers of arable land from April lst, 1951 to March 31st, 1952 in four villages in Akita and Iwate Prefectures. The results may be summarized as follows.

In farm villages the most urgent problem is still the land problem. For this reason, our investigation naturally centered on it. However, this problem is closely connected with those of farm financing, agricultural co-operative associations and farm management, and it will be often impossible to explain the essential character of the arable land problem if we disregard them. We tried, therefore, to include in our report the facts made clear by our investigation.

The present paper is merely a report of an investigation, and a theoritical analysis of the problem will be attempted after investigations are carried year after year and over wider areas. Investigations similar to ours were carried out simultaneously in farm villages throughout Japan and reference must be made to "Investigations on the Transfers of Agricultural Land in 1951–1952" by Yasuo Kondo and published by Agriculture and Forestry Statistics Society.

II. Structure of Agricultural Reproduction and Land Reform Process in Investigated villages

Our investigations being restricted to four villages, we roughly devided the prefectures into paddy field zones and mountainous field zones, and further divided them into progressive zones and backward zones, from aech of which we selected one farm village, taking into consideration the characteristic features of farm management in these regions. We carried out investigations in the following four villages.

1. Hanawakawa-mura, Yamamoto County, Akita Prefecture (Mountainous paddy field zone).

2. Shibahira-mura, Kazuno County, Akita Prefecture (Rice-raising and fruit-raising zone).

3. Nisattai-mura, Ninohe County, Iwate Prefecture (Mauntainous Corn-raising field zone).

4. Natsuta-mura, Isawa County, Iwate Prefecture (Level paddy field zone).

All four villages have in common with other farm villages in the Tohoku Region features characteristic of the farm villages in this region, but remarkable differences can be seen in the structure of farm reproductive process in these four villages. The differences are revealed in the tables prepared to show the transfers and inheritance of the arable lands and financial changes accompained by them, which are the objectes of our investigation. Let us first give simple descriptions of the features characteristic of each village.

1. Hanawakawa-mura.

Forty-minutes ride in a bus from the city of Noshiro in the northern part of Akita Prefecture takes ones to the village called Ōsawa where there is the village office. This village as the center several villages are located on the hillside in a sector. The characterestic features of the farm management may be summarized as follows :

(i) Management of mountainous paddy field single croping.

The area of the paddy field is about 630 *cho*, 80% of the whole arable land. It shows the highest rate of specializing in rice raising among the four villages. (Table 1).

Table 1 Land utilization (1950).

Kind of land		Hanawakawa			Shibahira			Nisattai			Natsuta		
		Area	Percentage		Area	Percentage		Area	Percentage		Area	Percentage	
		cho	%	%	cho	%	%	cho	%	%	cho	%	%
Paddy field	Single crop	672.9	100.0		580.6	100.0		67.8	100.0		912.4	99.4	
	Double crops	—	—		—	—		—	—		5.4	0.6	
	Total	672.9	100.0	85.6	580.6	100.0	55.6	67.8	100.0	11.9	917.8	100.0	82.1
Upland field	Ordinary field	109.7	96.5		343.5	71.1		474.8	94.7		197.6	98.6	
	Mulberry field	3.8	3.4		0.4	0.1		14.1	2.8		0.9	0.5	
	Orchard	1.4	0.1		139.4	28.8		12.4	2.5		1.9	0.9	
	Total	113.1	100.0	14.4	483.6	100.0	45.4	501.3	100.0	88.0	200.4	100.0	17.9
Grand total of agric. land		786.0		100.0	1,064.2		100.0	569.1		100.0	1,118.2		100.0
Forestry		140.1 (3,911.0)	74.8 (78.8)		80.1		30.7	973.9		80.0	88.1		74.1
Grassland		47.2 (1,050.0)	25.2 (21.4)		180.9		69.3	242.9		20.0	30.8		25.9
Total of forestry and grassland		187.1 (4,961.0)	100.0		261.0 (4,451.0)		100.0	1,916.8		100.0	118.9		100.0

Note : i) (Area)=State forest.
ii) 1 *cho*=10 *tan*=2.45 acres.

However, paddy fields are not as good as those in the level land. The patches are mostly those in swanps where irrigation and slope permit no further development of arable land, and they are all utilized for single crop a year.

Table 2. Rice yield per *tan* (1950).

Village	Upper class	Middle class	Lower class
Hanawakawa	2.5 *koku*	2.0 *koku*	1.8 *koku*
Natsuta	3.2	3.0	2.5

Note : 1 *koku*=0.18 kilo litre.

Therefore, the harvest per *tan* is much lower than that in Natsuta-mura, as will be explained later though they are both under a single crop a year management. (Table 2). No improvement can be seen in the farming implements, and it belongs to a backward type of management as a rice-raising zone. The characters of mountainous farming can be seen also in the management of fields comparatively a few in area. In spite of its favarable conditions due to its nearness to the city of Noshiro, field products are mostly corns and vegetables for their own consumption and practically no product for the market (Table 3).

Table 3. Planting area of staple crops (1949).

Wheat and Barley	35.0 *cho*
Soy-beans	29.4
Vegetables	23.6
Potatoes	21.0
Buckwheat	16.4
Other beans	5.9
Mulbery	3.8
Fruits	1.0

Consequently, from the table for income, it will be seen that all the farmers, except one whose income comes from fruit-raising, belong to those who devote to rice-raining or to self-sufficient farmer group. Their incomes are very low in amount, and 80 % (422 farms) is with the income of less than 150,000 Yen which is supposed to be the minimum necessary for simple reproduction in this village (Table 4).

Table 4. Number of farmers classfied by amount of award income (in thousand yen).

a. Number

Village	Total	less than 50	50–150	100–150	150–200	more than 200
Hanawakawa	530	169	137	116	63	45
Shibahira	755	275	285	144	41	10
Nisattai	650	142	341	114	32	21
Natsuta	813	191	199	220	131	72

b. Percentage (%)

Hanawakawa	100.0	31.9	25.8	21.9	11.9	8.5
Shibahira	100.0	36.4	37.8	19.1	5.4	1.3
Nisattai	100.0	21.9	52.5	17.5	4.9	3.2
Natsuta	100.0	23.5	24.5	27.1	16.1	8.8

(ii) Communistic system regarding the utilization of forestry and grassland.

The expansive uncultivated land is what keeps this village in mountainous type. The village has about five thousand *cho* of uncultivated land, which is larger in area than that of any other village investigated. It is mostry on the

slope of the hills and it seems possible to clear it up for cultivation. Despite this the cultivated field per house is about two *tan*. This is probably due to the following social condetions.

The greater part of forestry and grassland is the village-owend forestry resulting from the combination of community-owned woods in the village in the latter part of Meiji Era. The utilization of the forestry was kept in the hand of village, but in recent years, trees have been sold by auction, and a small part of the proceeds is turned over to the village finance, the remainder being divided among the villagers. Those who are entitled to the dividend are limited to those villagers living at the time when the communtiy-owned forestry were made village-owned, which practically amounts to saying that the dividend is given to those farmers which enjoy rather high social position. As the number of the founders share will never be encreased, new farmers which sprang up in later years have no means to the utilization of forestry and grassland except to obtain some part of the shares owned by their head farmers or landowners. Therefore, charcoal-making and cattle-raising (Table 5) which are chief source of income besides rice products are not available poor farmers. Forestry and grarssland is a factor which has given rise to a special social relation.

Table 5. Amount of revenue (1951, in ten thousand yen).

Rice	5.845
Forestry products (charcoal and others)	600
Live-stock	300

Furthermore the holders of the founders shares usually keep sufficient area of farm for their own cultivation and monopolize the field two *tan* per house mentioned above. There is no necessity for them to clear up forestry and grass land, and they will not permit those poor farmers who have intense desire to clear up it. Consequently, the arable land per house in this village is very small in area and there is a large number of farmers who own less than one *cho* of land.

The result of the keen struggles to get land is evident. It is probably due to these circumstances that transfers of land in this village were done in the form of purchase and sell rather than free gift to sons or others when they set up branch families, quite contrary to the tendency seen in other three villages investigated. Such a control system through the medium of communistic rules, regarding the ownership and utilization of forestry and grarssland is a dead block in a land reform, which is made a good use of by the landowners in their desire to recover the land lost through the land reform.

(iii) Petty landowners still exsist.

The concentration of the ownership of land characteristic in rice raising zone

is not so apparent in this village. For example, in 1947, 84 % of the whole farmers had no farm for tenancy and only four farmers had more than five *cho* of farm for tenancy (Table 6), although there was no absentee landowner in the village.

Table 6. Numbers of land-owners classfied by size of rented land. (1947)

none *tan*	481
less than 5	50
5–20	45
20–50	16
more than 50	4
Total	596

In short, there were comparatively few land for tenant even before the land reform and they were mostly owned by petty landowners. On account of this, the land released by the land reform law was small as compared with other farm villages. In other words, the dismemberment of petty landowners was not sufficiently carried out. Consequently, the status of the tenant farmers was hardly raised to independent-tenant class who accupies about 50% of the number of the whole farmers. After the land reform, pure tenant farmers have been decreased to seven houses, but there are still 167 farmers who cultivate lands leased under some sorts of contract (Table 7).

Table 7. Number of farmers classfied

Village	Year	Total		Owner	
		Number	Percentage	Number	Percentage
Hanawakawa	1947	596	100.0	230	38.6
	1950	576	100.0	211	36.7
Shibahira	1947	697	100.0	113	16.2
	1950	737	100.0	654	88.7
Nisattai	1947	505	100.0	275	54.4
	1950	511	100.0	403	78.9
Natsuta	1947	721	100.0	194	26.9
	1950	785	100.0	522	71.0

For the circumstances described above, the land tenanted are still owned by petty landowners as their property. In the village where the paddy field have been developed from marshes, the rice-nursery are of special importance and a custom prevails that the farm rent for such rice-nursery are usually 10% higher than that for the best patches. These rice-nursery are still in the possession of the petty landowners. The same is true of the irrigation system, and the application of the land reform law did not extend the residence of the landowners. The utilization of the forestry and grassland have already been described.

Petty landowners resident in the village are considered to be those who excerise their right most tyrannically. In fact, we find in this village many reforms carried out in distorted manner. In the tenant farm which is still in the possession of the petty landowner and where complicated relation of landowner with tenants remain unsettled, the farm rent is usually charged in the form of one bale of rice per *tan* and in the villages with less area of paddy field, it is two bales per *tan*. The lands tenanted are tended to be taken back by the landowners, and the transfers of lands through purchase an sale in this connection, was largest in this village. Details of how it is done will be given in later sections, but it should be observe that the rise and fall in the social class in this village is brought about not by superiority or inferiority of farm management, but by struggles for the possession of the land.

2. Shibahira-mura.

This village is located almost in the center of Kazuno County which is the northeast corner of Akita Prefecture. The towns of Kemanai and Hanawa along the Hanawa Railway Line are not far from here, and so are Kosaka and Osarisawa mines. It is on the west slope of the Ōu-Mountains where we find woods uncultivated land, cultivated fields and paddy fields in the order named from the top. We find villages here and there on the level land or by marshes.

(i) Rice-raising and fruit-raising.

As shown in Table I, different from other three villages, this village is not dependent upon one of the two, field cultivation and paddy field cultivation, the

by owner and tenant.

Owner-tenant		Tenant-owner		Tenant		Actual tenant-farmer	Its total
Number	Percentage	Number	Percentage	Number	Percentage		
101	16.9	136	22.8	129	21.7	...	...
288	50.0	45	7.8	7	1.2	167	
177	25.4	225	32.3	182	26.1	...	...
72	9.8	4	0.6	6	0.9	198	224
105	20.8	52	10.3	73	16.5	...	...
85	16.6	16	3.1	7	1.4	146	190
220	30.5	186	25.8	121	16.8	...	...
180	24.8	21	2.9	10	1.3	327	585

ratio between them being a little in favar of paddy field cultivation. Most paddy fields are under a single crop a year, and nothing in particular can be said of their farming technique. About 200 *cho* of fields are utilized for raising fruits, mostly apples (Table 1 shows the arcrage recorded in the official book which is quite far from the actual one), and the village is one of leading fruits centers in the prefecture. This is the first characteristic feature of this village which distinguish it from other three villages. It is diagnoally different from Nisattai-mura to be described presently in character, though they are under the same

conditions historically and geographically.

This village was under the administration of the Nambu clan in the days of feudalism, and its natural conditions are the same as those in the northern parts of Iwate Prefecture. Consequently, it had many characters representative of "Nago" system (feudal-serf system) in its social structure until the latter part of Meiji Era when fields were devoted to the raising of corns. In fact, we found a good example of "Tsukurigo" or "Ieko" system on a large scale which had been maintained until the land reform, as in the case of "K" family in Koesashi community. For reference, we would like to give here a table (Table 8) showing

Table 8. The yield of staple crops.

Plants	Amount of Products	Amount of cash	Price per *koku*
Rice	6,740 *koku*	53,632 yen	8 yen
Millet	1,120	6,720	6
Soy-beans	1,091	5,459	5
Panic-grass	360	648	1.8
Buck wheat	200	600	3
Small-beans	72	432	6
Potatoes	80	320	4
Hemp	2,730 *tan*	359	—
Vegetables	....	800	—
Fruits	....	400	—
Radishes	75,000 *koku*	937.5	—

Note: i) Data based on "Suitable plantation" by Rikinosuke Ishikawa, 1897.
ii) 1 *kan*=3.75 kilograms.

the names of crops raised and yield harvested in 1897 on the basis of an extremely detailed investigation made by Rikinosuke Ishikawa. According to his investigation, the yield of rice per *tan* was one *koku* two *to* seven *sho* nine *go* (1 *koku* = 10 *to* = 100 *sho* = 1,000 *go* = 0.18 kl) on five-year average until 1897, because of successive infavorable climate year after year. The farm management was still in infantile stage and apple-raising had not yet been adapted. To our surprise, even find, however, the land given to apple-raising was encreased to 72

Table 9. The amount of cash income by staple crops.

Plants	Pranting area (A)	Cash income (B)
Rice	456 *cho*	28,000 thousand yen
Fruits	165	27,500
Soy-beans	50	80
Millet	30	—
Vegetables	20	90
Potatoes	19	30
Wheat and Barley	18	90

Note: (A) based on the data of 1947.
(B) based on the data of 1952.

cho in 1912 and apple trees were 21,825 in number. In 1917, the farmers engaged in farming and pomiculture were 328 in number. In recent years, there are farmers who have given 4 *cho* of land to fruit-growing, and the total output of the village amounts to 400,000 boxes of fruits in the year of aboundant crops, bringing in cash income almost equal to that from rice (Table 9). Today the type of agriculture in the village has been changed from cold-zone self-sufficient corn farming to pomiculture.

The acreage under cultivation per house is large, and as seen in the table, ther are comparatively few small-scale farmers, most of them being in the upper-class farmers (Table 10). Raising live-stock on pasture is done extensively, and for these reasons, this village has the least number of farmers who have to do some other work in addition to farming. The transfers of land was the smallest of all four villages, and most of them was done in the form of free gifts from fathers to sons at the time of making branch families.

Table 10. Number and percentage of farmers classfied by size of cultivating land.

Village	Year	Total		less than 3 *tan*		3–5		5–10		10–15		15–20		20–30		30–50		more than 50	
		Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Hanawakawa	1947	596	100.0	21	3.5	41	6.9	157	26.3	141	23.6	134	22.5	97	16.3	5	0.8	—	—
	1950	576	100.0	23	4.0	34	5.9	157	27.3	127	22.0	120	20.8	106	18.4	9	1.6	—	—
Shibahira	1947	690	100.0	20	2.9	27	3.9	142	20.0	160	22.9	162	23.2	159	22.8	25	3.6	2	0.3
	1950	737	100.0	36	4.8	29	3.9	165	22.4	176	23.9	170	23.1	136	18.5	24	3.8	1	0.1
Nisattai	1947	505	100.0	41	8.1	34	6.8	135	26.7	151	29.9	87	17.2	57	11.3	—	—	—	—
	1950	511	100.0	51	10.0	44	8.6	121	23.7	138	27.0	98	18.2	61	11.9	3	0.6	—	—
Natsuta	1947	721	100.0	22	3.1	29	4.0	143	19.8	190	26.3	185	25 7	130	18.0	22	3.1	—	—
	1950	735	100.0	21	2.9	40	5.4	130	17.7	182	24.8	205	27.9	133	18.1	24	3.2	—	—

(ii) Complete dismemberment of absentee landowner.

The ratio of independent farmers in this village was smaller than any other villages under investigation before the land reform (Table 7), and the ratio of tenant farmers was greater than any other. This was more remarkable in paddy field and tenant farms were in the hand of merchants or money-lenders on harvest in Hanawa and Kemanai. The possession of the land by such absentee landowners was seen even in old days and nearly 40% of farms in the village had been in their hand by 1897 (Table 11). About 40% of the total yield of rice had been taken away from the village to other towns and villages. There, only 59% of the farmers was independent.

The land reform law has brought about a complete change in the ownership of land. As the farms owned by absentee landowners were released unconditional-

ly, the greater the number of such lands, the more easily the reform was carried

Table 11. Area of field ownend by absentees (1896).

Kind of field	Sum total of area	Absentee's owned land	
		Area	Percentage
Paddy field	634.2 *cho*	358.8 *cho*	56.6%
Field	569.8	131.7	23.1
Total	1,204.0	490.5	40.0

Note : Data based on Rikinosuke Ishikawa, ibid.

out, releasing completely the lands owned by absentee landowners. In short, we cannot see in this village the dominating landownership by the landowner resident in the village as in the case of Hanawakawa-mura. Moreover, although there is about 5,000 *cho* of forestry and grass land in the village, but the greater part of it is owned by the state, which makes it difficult for the landowners to regain their dominating power through the possession of such lands.

As a result of the land reform, the ratio of independent farmers to tenant farmers is put on a more desirable basis than in any other villages. It is quite natural that the transfers of lands through the purchase and sale of the right of cultivation and the ownership of the land were smallest in number at the time when the present investigation was carried out.

However, there still remains 14% of tenant farms, and how they will be transferred will be the problem for the Agricultural Land Cmmission whose decision will be watched keenly.

In this village, private-owned forestry and grassland were a few in number, and villagers in each village used to get a part of public-owned wooded land granted through special favor or to have it in trust, or to lease pasture land for live-stock under communistic utilization. On account of this, they have to furnish labor at a very low wage for the administration of public-owned forestry independent of agriculture. This is perhaps one of the reasons why the release of public-owned wood has been so emphatically advocated.

Table 12. Classfication of owner and tenant (1911).

Classification	Number	Percentage
Owner	28	5.9
Owner and tenant	310	67.4
Tenant	122	26.7
Total	460	100.0

3. Nisattai-mura.

The town of Fukuoka is in the northern part of Iwate Prefecture along the Tohoku main line of the Government Railway. Nisattai-mura is the village that

encircles the town from the east. The district is west of the zones popularly called the Japan Tibet, forming tablelands which are conected with branch ranges of the Kitakami Mountains.

Consequently, the greater part of the village is covered with poor copse hills. Small villages are found between the ranges. The farthest community is located 15 kilometers from the village office. The character of the village is clear from the description made above.

(i) Selfsufficient farming of corns in cold-zone

This village is in that farm village group which runs farms under most unfavorable natural conditions looking at the ratio of arable land (Table 1), we find that paddy field are only 1% of the whole arable land. Except those along the river Mabuchi, paddy field are found on the slopes, one above another. They may be said to be typical field zone, mostly producing those corns that can stand cold climate, but their productivity is very low (Table 13). For example, a

Table 13. Staple crops and its yield per *tan* (1950).

Plants	Area	Yield per *tan*
Rice	68.0 *cho*	1.14 *koku*
Panic grass	202.1	3.29
Soy-beans	181.8	1.14
Wheat	132.4	0.92
Barley	33.0	1.21
Millet	38.8	0.54
Buck wheat	25 6	0.75

specie of millet called *hie* (panic grass), which is no longer planted in other regions, is still raised here to the extent of about 40% of the arable land being used by the villagers as a staple food. The method of cultivation still remaisn in infantile stage. For example, they raise millet, barley and wheat and beans on the basis of three crops in two years, but there is about 30 *cho* of land remaining idle, either as researved for rotation of crops or as unstable arable land.

The crops are rotated on these lands, beans in the first year millet the second year, beans or millet in the third year and reforestation the fourth year. In the case of the first clearing up of wooded land, reforestation takes place every fifteen years with the rotation of crops.

In addition, the absolute acreage under cultivation per house is the smallest of the villages under investigation, 40% having less than one *cho* (previously given Table 10). Thus the income from farm produce is less than 50% of the whole

Table 14. Amount of products (in thousand yen, 1950).

Agricultural products	16,746 yen	48.4%
Forestry products	14,750	42.6
Sericulture	3,118	9.0
Total	34,604	100.0

income of the village, insufficiency being supplemented by those of sericulture and making fire wood and charcoal. In particular, products from forestry form a principal source of income for the villagers, being more than 40% of the whole income (Table 14).

But, as usual in the case of a village, the owners of forestry absorb the larger part of such incomes, farmers earning a small amount of wage. Consequently, we find in this village a large number of those who are engaged in two kinds of labor, especially among these who are engaged in forestry labor (Table 15). In this manner, the standard of living in this village is the lowest among the four, 483 houses earning less than 100,000 yen a year, being 74.7 % of the whole village.

Table 15. Classfication of farmers by subsidieary work.

Village	Year	Farm only		Subsidiary (number)				Gland total		Farm population	
		Number	%	Type I	Type II	Total		Number	%	Total	Per farm
Hanawakawa	1947	500	83.9%	74	22	96	16.1%	596	100.0 %	3,759	6.3
	1950	319	55.4	210	47	257	44.6	576	100.0	3,915	6.8
Shibahira	1947	508	72.9	134	55	189	27.1	697	100.0	4,530	6.5
	1950	631	85.6	81	25	106	14.4	737	100.0	5,703	7.7
Nisattai	1947	...	...	...	...	...	...	505	100.0	3,325	6.6
	1950	303	59.3	132	76	208	40.7	511	100.0	5,540	6.9
Natsuta	1947	596	82.7	91	34	125	17.3	721	100.0	5,114	7.1
	1950	548	74.6	157	30	187	25.4	735	100.0	5,125	7.0

(ii) Backwardness in social structure (Existence of *nago* and metairie system).

This village and its surrounding sections were noted for the existence of *nago* system on a large scale until very recently. Being near to the railway and to quite a large town of Fukuoka, their were no longer any large landowners with a large number of *nago*. However, the tenant system in the form of share croping (metairie) system was predominant in the village until the land reform, and the *nago* system also existed to great extent. For example, the share croping system under a fixed ratio was in force in the case of paddy field which had evolved even to a tenant rent in the form of a definite amount of farm produce a year. It was because the farm crops were unstable from year to year.

Under the share croping system, the crops were evenly divided between the landowner and tenant, but the latter received 40% of the crops when he got a share of seeds. He furnished necessary labor until the harvest, took gathered crop alternately with the landowner, and any operation after this stage was done independently of each other. This was true of the tenancy of fields, the regulations being applicable to farm crops of all the seasons. In the case of corns, the crop was divided at the ratio of 60% to the landowner and 40% to the tenant, seeds

being included in the share of the tenant. In the case of potatoes and vegetables, the quantity of the share was culculated in terms of soy-beans or in money. In the case of roughly cultivated lands or burned fields, the crop was divided between them at the ratio of 30% to the landowner and 70% to the tenant, and when they were leased under a regular contract, the regulations mentioned would be applicable ten years hence. Under the tenancy either of paddy field or up land fields, the tenants were forced to furnish free labor three or five persons per *tan* a year. Strange as it may seem, the landowners were allowed to plant mulberry trees around the tenant farms, but the tenants were not allowed to do so. Consequently, the tenants had to buy mulberry leaves when they wanted to carry sericulture, but substantially it was impossible. The income from the sale of mulberry leaves often surpassed the products of this tenant farm because sericulture was a very prosperous industry in the village.

In adition to these, cattle industry in the form of trust was predominant. Leeding expenses were barne by the keeper, while proceeds from the sale of cattle were divided at the ratio of 40% to the owner and 60% to the keeper. Even now more than 20% of cattle in the village is kept under this system.

When the utilization of forestry and grass land is limited to a definite extent and for a long time, the tenants must furnish, at a request of the landowner, labor service. The number of days for such labor is not fixed, being five days a year in most casess. Besides these regular tenants of forestry and grass land the landowners have charcoal burners and common forestry workers. About 40% of the farmers in the village belongs to these dependent classes.

Means of production such as paddy field, fields and agricultural forest are tenanted separately sometimes, but they are usually tenanted en bloc by poor farmers.

Now let us see how these problems have evolved since the land reform. Needless to say that agticulture in every village is carried on with arable land as its principal means of production. But it does not necessarily mean the reproductive process in agriculture is carried on with arable land alone. It is due to the participation in it of many other subsidiary means of production which alternately support one another that arable land is capable of fulfilling its fundamental function in reporoductive process. In scuh a stage of social development as this village had where social differentiation of such means of production is prevented by self-sufficiency of production, and consequently by the weakness of farm economy, the ownership of arable land means the ownerships of all other menas of production, and in fact, the ownership of land and social structure in this village proved to be the same in character as those mentioned above. Therefore, the land reform was limited in effect although in aimed at a complete dismemberment of the landowners in the village.

As in the case of Shibahira-mura mentioned in the preceeding section, the

greater part of tenant land in this village was owned by the absentee landowners in the near town of Fukuoka. As to the manner of emancipation of land, however, there was a great difference between the two towns. The landowners in Fukuoka were absentee owners, according to the administrative division of area, but they were resident owners economically, hading close economic relations with the village. Consequently, their resistance to the land reform was very strong at the early stage of compulsory purchase of land even refusing to sell business stationaries to the agricultural land commision, on a account of which eight clerks working under the commission were forced to resign from the past untill april, 1948. In spite of such difficulties the emancipation of tenant lands was completely carried out, leading a small area of tenant land, as shown in Table 16. Here, it must be pointed out that the tenant system still exist in the lease of forestry and cattle, and very few farmers are worthy of being called independent farmers.

Table 16. Percentage of rented farm.

Purchased farm by the government	Absentee's rented farm	105.3 *cho*	77.4%
	Resident's rented farm	22.4	16.8
	Others	7.9	5.8
	Total	135.6	100.0
Tenant farm remained after land reform		33.6 (5.9%)	

Consequently, there have been constant attempts by the landowners to recover their lost lands. If the bar in the farm of regulations concerning the absentee landowners is lifted, it is feared that the lost lands will be recovered very easily by the former owners. It was observed that the struggle had been intensified to get the ownership of the lands which the resident landowners managed to keep for themselves.

To the question submitted at the time of "The Survey of Works done in the Emancipation of Agricultural Land", the agricultural land commission replied on August 1, 1950.

"Of the independent farmers resulting from the release of farm and having only a small area of land, many were forced to sell their lands in black market by abandoning them through poverty existent in the farm community, as the result of reactions in free economy caused by peculiar characteristic of mountainous arable land utilized for raising corns." This statement is suggestive of what has been going on in the village.

4. Natsuta-mura

This village is located in the southern part of Iwate Prefecture, a little west from the town of Mizusawa. The area around it forms the Isawa Plain often called the granary of Iwate Prefecture.

(i) Typical paddy field region

The characteristic of this village is that it is a single rice-products region.

Different from paddy field and fields in other three villages already mentioned, paddy field extend one after another over a plain level of land. According to Table 1, there is a small area of forest in the village but it is, in fact, outside of the village, and not a hill is to be seen in the village. More than 80% of arable land has been turned into paddy field, of which 5.4 *cho* are utilized for double crops. From the standpoint of size, this may not be worthy of our special notice, but it is something that cannot be seen in other three villages and it is growing rapidly among the villagers. This is an effort made through rationalization of farm management to remove the weaknesses of single-crop zone, and it can be seen in the fact that six cultivaters driven by motor were purchased in the year 1947. A great difference can be seen between Hanawakawa-mura, also a single-croping village and this village in the size of farming implements and labor animals. (Table 17). Consequently, the quantity produced per *tan* is greater than in any other village (Table 2).

Table 17. The condition of the agricultural implements and labor animals (1950).

Village	Motor		Labor animal	
	Number	Number of farmers per motor	Number	Per farm
Hanawakawa	48	12.4	476	0.79
Natsuta	176	4.3	716	0.93

The tendency to rationalize management of paddy field can also be seen in the utilization of fields. Fields, though only 18% of the whole arable land, are utilized to raise tobacco-plants (9.2 *cho*) and *hakusai*.

Arable land under the management of a farmer is the largest in the four villages under study, being over 1.5 *cho* Accordingly, the classfication of farmers by the size of arable land is most desireable, and farmers with less than five *tan* of arable land is the smallest in number. There are, on the contrary, a large number of upper-class farmers and their number is on the increase (Table 10).

The standard of living is relatively high and there are 423 farm houses with the annual income of over 100,000 yen according to the calculation of the Tax Office being diagonally opposite to Nisattai-mura mentioned in the preceding section (Table 4).

(ii) Still remaining of tenant-farmers on a large scale.

Previous to the land reform, there was relatively a large number of tenant lands in this village. Today, however, the greater part of the tenant lands were emancipated, only 6% of the whole arable land still remaining under tenant system (Table 18). The ratio of tenant farmers is only 1% which fact clearly shows a success of the land reform. As well known, the table for the number of

Table 18. Area of paddy and upland field classfied by owned and tenant (*in cho*)

Village	Year	Paddy field					
		Owned-farms		Tenant-farms		Total	
		Area	Per-centage	Area	Per-centage	Area	Per-centage
Hanawakawa	1947	422.8*cho*	66.4%	214.1*cho*	33.6%	636.9*cho*	100.0%
	1950	535.2	87.8	74.6	12.2	609.8	100.0
Shibahira	1947	181.5	33.9	353.4	66.1	534.9	100.0
	1950	472.9	81.4	108.1	18.6	581.0	100.0
Nisattai	1947	36.6	59.1	25.3	40.9	61.9	100.0
	1950	63.2	93.2	4.6	6.8	67.8	100.0
Natsuta	1947	582.4	61.6	363.2	38.4	945.6	100.0
	1950	862.4	94.0	55.4	6.0	917.8	100.0

Village	Year	Upland-field					
		Owned-farms		Tenant-farms		Total	
		Area	Per-centage	Area	Per-centage	Area	Per-centage
Hanawakawa	1947	87.7*cho*	86.0%	14.4*cho*	14.0%	102.0*cho*	100.0%
	1950	171.7	97.4	4.5	2.6	176.2	100.0
Shibahira	1947	267.0	59.0	185.6	41.0	452.6	100.0
	1950	422.2	91.5	41.0	8.5	483.2	100.0
Nisattai	1947	293.2	67.1	143.8	32.9	437.0	100.0
	1950	472.3	94.2	29.0	5.8	501.3	100.0
Natsuta	1947	124.8	70.5	52.3	29.5	177.1	100.0
	1950	189.6	94.6	10.8	5.4	200.4	100.0

independent and tenant farmers in made on the basis of the ratio alloted to the tenant lands (independent arable land) out, of the land under the management of individual farm house. Apart from this ratio, another study into the number of farm houses managing tenant lands, that is, how many farm houses get hands in the remaining tenant lands, will reveal us quite a different situation. That is

Table 19. Number and percentage of tenant farmer (1950).

Village	Remaining tenant farm		Tenant farmer by official classfication		Tenant farmer by actual condition	
	Area	Percentage	Number	Percentage	Number	Percentage
Hanawakawa	79.1*cho*	10.1%	7	1.2%	167	28.9%
Shibahira	149.1	14.0	6	0.9	198	26.8
Nisattai	33.6	5.9	7	1.4	146	28.5
Natsuta	66.2	5.9	10	1.3	327	44.5

to say, according to Table 19, in each village, about 30% of farmers manages tenant lands in one farm or other, and in this village about half the number of farmers falls into this class, being 589 in number (80%).

This is merely a consideration of the actual state of independent farmers created by the land reform law, taking only the arable land as and example, and it is quite probable that the number of independent farmers in strict sense may still be reduced if other farm facilities are taken into consideration. In the present survey transitions of tenant lands, consequently, transitions of independent farm lands were observed to have taken place wherever we went.

This is true of this village where the system of farm management is excellent and farmers' organizations are highly developed.

(ii) Relativety excellent managing of agricultural co-operative association

How agricultural co-operative association work will be explained in detail later in connection with the procurement of funds necessitated by the transfer of arable land, but it is taken up here only in connection with the frequency of transfer. Agricultural co-operative association have been in general at a low ebb recently, but this was especially pronound in the other three villages. For example, as shown in Table 20, the definit in the funds invested has been accumulated to

Table 20. The condition of agricultural co-operative association (1950).

Village	Number of members	Funds (in thousand yen)	Profit and Loss (in thousand yen)
Hanawakawa	640	4,009	−3,442
Shibahira	779	860	−4,283
Nisattai	483	281	− 667
Natsuta	816	4,197	+ 230

an amount almost unbearable. In Hanawaka-mura, the bad debts ran up to 3,500,000 yen, which it is almost impossible to recover. Farmers have almost no confidence in the co-operative association, and when they get payment for the rice supplied to the Government, they take it out of the co-operative association on the very day to deposit it at other financial organization. In Shibahira-mura, the co-operative association has no hand in the disposal of apples raised there to an annual production of 400,000 boxes. The same thing can be said of the payment for the rice. In Nisattai-mura, much cannot be expected of its co-operative association as it is an union for the farmers who raise mostly corns, but recently it has completely overwhelmed by aggressive merchants. In all three villages, bank deposits have been on the steady decrease, whereas bank loans have been on the rapid increase, and, in fact, the bank loans have surpossed the bank deposits in a certain village. Natsuta-mura is the only village where the co-operative association shows a surplus in credit on the balance sheet. For this reason, it enjoys hearty supports of the partners and a large sum of deposit. However it has a considerable amount of loans, which are on the inscrease recently. It has supplied the partners with considerable amounts of running funds, and no symptoms can be observed at present of going out of the purpose for which it was created. It

may be mentioned here that this co-operative association is one of the most excellent ones in the Prefecture, and this is the only one in the villages under our study that is carrying out works worthy of a agricultural co-operative association.

The circumstances described in the preceding sections farms a fundamental base on which to explain the transitions taking place in the farm villages. The above descriptions may have been somewhat meddlesome if it had been merely to give a general idea on the actual conditions in the villages under our survey, but transitions in farm villages have been taking place in a very limited extent, and many incidental factors are observed in them. It is risky to induce a general law governing the transitions in farm villages from statistics made from examples observed in these four villages. In order to aviod such a risk, descriptions have been given of particular disturbing circumstances in each village.

III. Tendency in Transfer of Agricultural Land

1) Tendency in transfer of agricultural land

Table 21 shows the number of transfers of agricultural lands according to laws under which they were effected. It is to be noted that the sale and purchase

Table 21. Case of transfers.

Law	1949	1950	1951
Sale and purchase under "Owner-Farmer Estabtiment and Special Measures Law"	206	80	40
Transition under "Agricultural Adjustment Law"	20	144	113
Transition under "The Potsdam Ordianance" (Article II)	—	—	112
Withdrawal and return under "Agric. Adj. Law" (Article IX)	9	18	27

of land by the government under "Owner-Farmer Establishement and Special Measures Law" has come to an end, showing a rapid reduction in number from year to year and that the number of the transfer of ownership under "Agricultural Land Adjustment Law" (Article IV) and that of the compulsory transfer of ownership under "The Potsdam Ordinance" (Article II) is on the increase. The number of return or withdrawal of tenant land under "Agricultural Land Adjustment Law" is also on the steady increase.

The figures given the table shows the number of cases handled by agricultural land commission and there must be a large margin between these figures and the number of transfers of ownership actually occurred. The figures for the year 1951 in which the present survey was done, include a fairly large number of transfers of ownership done privately in the confusions of the land reform, of the transfer of tenancy, and of the transfer of ownership in the farm of free gift. To cite an extreme case the figures for Hanawakawa-mura show those

which were disposed according to the law, though they had been transfered in the early part of Showa Era or during the World War II but formal registry was neglected, as seen in every village.

In contrary to such cases there are cases in which the transfer of ownership was actually made in 1951, which the figures for that year did not show. The transfers indicated as unregistered in the table correspond to such cases. In such a case, a transfer not registered for a certain year may be recognized as registered for another through an application of some law, the transfer of ownership is once established. Then it will be included in the number of transfers of ownership under the law for that year. It is quite probable that the agricultural land commission, though they may be aware that such an act is against laws, cannot force it back to its former status.

In short, the number of transfers of ownership done in a perfunctory manner under the law does not tell the actual condition of the transfer of ownership. It is due to such circumstances as these that the transfers of ownership under the law surpass that done privately in number.

The number of transfers of ownership for the year 1951 is not so large as has been said, but it is, also true that transfers of ownership are on the steady increase lately. Let us now look into the case in detail.

How land problems rise and how they are dealt with are different with different villages, and although it is difficult to trace the transfer of ownership to its original time, it is done in the following manners as seen from the instances adjusted. The transfers of ownership done privately between the parties concerned before and after the land reform disappeared with the start of the Government purchase (sale). In 1949, the sale of land by the old owners who found it impossible to keep farms under the new farm economy, and by small-scale ownerfarmers going out of or coming in farm business came to be in fashion and with it the withdrawl of tenant lands. This tendency still grew in force in 1950. It is about the circumstances existing before the enforcement of the "Ordinance concerning the Owner-farmer Establishment and Special Measures Law" on September 1, 1950 that the agricultural land commission Nisattai-mura pointed out "Many were forced to sell their lands in black market — as the result of reactions in free economy, caused by peculiear characteristic of mountainous arable land", as mentioned previously. In Hanawakawa-mura, the sale of tenant land appeared July, 1950, and the agricultural land commission gave us the following explanation. There were frequent revocation of tenant lands, with the dissemination of the idea that the land reform had come to an end because of the rise in the tenant rent and in the price of rice, although the transfer of lands and the control of rents were strictly enforced at the time of the termination of the Second World War. If a tenant refused such a demand, the landowner forced him to pay unreasonable rents. If the tenant refused it, the owner said he would sell the

land to others. Driven to the corner, the tenant was forced either to purchase the land or to pay the rent asked for". Under circumstances as these, the agricultural land commission has been put in such a position as not to be able to discharge their proper duty. Such things seem to have been prevailing from the latter half of 1950. It may be due probably to the fact that the idea of "black market" which had been a mighty pillar to maintain the social order in farm villages, began to go out of the mind of peopls about that time when the price control was gone out of force in farm land and in its stead. "The Potsdam Ordinance" was put in enforcement. Middle and small landowners were the first to take advantage of such circumstances, those who had farms too small for their own labor revoked the tenant land, and those who had more than their own labor could manage sold the tenant lands. At any rate, either the revocation or the sale of the tenant land was so manipulated as to charge unreasonable rents.

The transfer of land was often done in the farm of free gift to a branch family or in the form of sale for such a purpose, simultaneously with the transfers of ownership under the law. With the dissemination of the aim of "The Potsdam Ordinance," a new form of transfer of land by creating newly owner-farmers came in to existence. Thus, the latter half of 1950 as a turning point, the transfer of ownership increased in number toward the spring of 1951, and the tendency has grown in force pronouncedly of late. There are many instances where the committee encouraged the transfers or gave expost facts approval to such transfers, This tendency is particularly strong after the enforcement of "The Potsdam Ordinance".

2) Actual state of transfer under law.

(i) Transfer under article IV of "Agricultural land adjustment law".

As previously stated the number of transfers for each year is based on the perfunctory time of approval. The application of various laws varies in their contents. Even if they were of the same content, laws applied vary with villages, causing a series of confecsions. For example, the cases of transfers under the Article IV of "the Agricultural Land Adjustment Law" during the years under the present survey amounts to 99, of which 22 were effected in Hanawakawa-mura until November of 1951 and the transfers since then have come under article II of "The Potsdam Ordinance." Table 22 shows 76 cases of transfer effected in

Table 22. Case of farm transfers classfied by contents, under "Agricultural Adjustment Law", article IV, in Natsuta-mura.

Contents	cases	percentage
Exchange and consolidation	12	15.8
Sale and perchase	18	23.7
Free gift	20	26.3
Ruins	26	34.2
Total	76	100.0

Natsuta-mura with some adjustments. Of the reasons for the transfers it may be seen that the perfunctory transfer to the village or to the Government in the form of free gift in the case of rehabitation work of flood disasters or expansion of irrigational system was the largest in number, but they fall in the category of unavoidable administrative disposal. Next come the life-time inheritance of land in the form of free gift. Besides these, there are 12 cases of exchanges and consolidations of one with another. There are only 18 cases (23.7%) which the transfer was effected in the form of sale and purchase directly between the parties concerned.

(ii) Compulsory transfer under Article II of the Potsdam Ordinance.

The transfer under this law increased in number with the increase in the number of transfer under Article IV of Agricultural Land Adjustment Law, reaching the total of 121 cases, but there were some confersions as to the application of the two laws, as was pointed out previously. In Table 23, it is to be noted that the transfers under this law were effected in the form of sale and purchase between the parties concerned in contrary to those under Article IV of Agricultural Land Adjustment Law. This is due to the increase in the total number of transfers for the years under the present survey and to the time of enforcement of the law (September 11, 1950), but, what is still more important, the transfers of the ownership of newly created ownerfarmers far surpossed in number those of the old owner-farmers.

Table 23. Number of cases compulsory transfers under Article II of "The Posdam Ordinance".

Village	Sale and purehase	Gift	Exchange and consolidation	Instantaneous sale for financing purpose	Ruin	Total
Hanawakawa	17	6	1	—	—	24
Shibahira	7	13	—	—	—	20
Nisattai	9	—	—	20	—	29
Natsuta	10	—	—	15	14	39
Total	43	19	1	35	14	112

The most important question in this case is that of its price, but it will be explained in detail later. However, even if the control of price had gone out of enforcement, the difference $\frac{n}{10}$ between the price actually paid and that provided in the law should be paid to the Government (Article III or V). Such instances are none, for it is a common practice to submit a price based on the lowest price agreed upon between the parties concerned. The agricultural land commission will never inquire into such a matter consequently, there are cases where agricultural land is sold as a residental site and gained unearned profit from it, for which the former landowner from whom the transfer had been effected had great

dissatisfaction. These things caused the landowner to charge unreasonable rent or to force transfer of ownership.

Although the transfer was effected in the form of sale and purchase, yet, in fact here are many cases where the transfer was effected in the form of free gift, and these together with those under Article IV of Agricultural Land Adjustment Law are quite large in number.

This will give rise to division of agricultural land into further small scale. To return to the subject, the transfer of ownership in Hanawakawa-mura and Shibahira-mura is approved only by The Potsdam Ordinance, where as in Natsuta-mura it is approved by Agricultural Land Ajdustment Law (Art. V). If the both laws meet the requirement of agricultural lands whose reform they aim at, then take recognition of the class (for example, the head family) who gives the free gift, of which another consideration has to be made.

(iii) Instantaneous sale for financing purposes

Of the transfers under the Potsdam Ordinance there were 35 cases of "Instantaneous sale for financing purposes to the Government" (The Potsdam Ordinance Art. II, Item 1, Owner-farmer Establishment and Special Measures Law, Art. IV), of which 18 cases were approved.

In this form of contract, the sale purpose is to get funds, the contract of sale being effected with the Government instantly in business-like manner without any change in the owner. Even if it were changed, it would be a change in the name of the title holder in the family, there being no actual transfer of the ownership. Therefore, the important question here is not whether the actual transfer was effected or not, but the cause for asking for such funds, or how the funds are utilized between the classes, and further, for what purposes they are expended. They will be explained under the title "Transfer of Agricultural Lands and Financing", so we describe here merely how they are handled by the committee at the further end of the system.

In 1951, this form of contract was not well appreciated at the beginning, consequently, effected only in certain particular villages, because the funds to be, financed were small in amount and complicated in procedure. In Akita Prefecture there was an allotment of 9,000,000 yen in all, but the two villages under our survey did not utilize it all. On the contrary, the two villages in Iwate Prefecture made good use of it, Nisattai-mura in particular utilizing even the funds allotted to three other villages surrounding it. But not all the applicants got the funds, for in Nisattai-mura 10 out of 20 and in Natsuta-mura 8 out of 15 got the allotments, and the selections were made at the will of the committee. For example, viewing those who got the allotments from the standpoint of social class, it will be seen that the largest number of allotments were given to the upper class farmers who were not in need of such funds, whereas they were given to only one farmer in the lower classes who were really in need of them, and that much smaller in amount.

Such a contradiction as this can be seen in the uses to which such funds are put. In 7 cases, they were used in connection with inheritance of properties, they were spent not as expenses incurred in inheriting properties but as a preventive measure to avoid such expenses in the future. That is to say, the agricultural lands in the name of grandfather or father, who are to transfer them in very near future, are sold to the Government, and their successors purchase them outright, to escape the payment of inheritance tax or registration tax.

In short, the funds were principally used in making repairs of workshops, in improving lands and in making payment for the lands which were to be transferred. Even if there had been no such funds, they would not have been driven to sell their lands. In 3 cases, the funds were used as living expense (medical expense) and in the payment of fertilizer, all in the lower classes. Even in such cases, the funds did not serve as a means to prevent the lands from being sold, because the cause for the sale of agricultural lands is not so simple in nature as to be done away with such a small amount of funds as these, which were less than 1 % of the price at which the lands were transfersed. To the question asked of those who had transferred the lands "Would you sell your land even if you made use of the funds now available ?", they answered unanimously "We will sell". Therefore, it is quite questionable to what extent these funds prevented the owner-farmers from falling to tenant farmer class.

(iv) Transfer of the right of tillage and revocation of tenant land.

(A) Transfer of the right of tillage.

We shall deal with the actual state of so-called "the right of tillage" in detail later, but there were only 3 cases of transfer of the right of tillage under law in Nisattai-mura. The transfers were not effected through the mediation of landowner nor by the right of "*Uwatsuchi*" (tillage) between the tillers themselves. They were, in fact, the transfers of the right of tillage to those who were to form a branch family. These cases should be included in the free gift, but they came under "Agricultural Land Adjustment Law," Art. IV "The Potsdam Ordinance," Art. II because they are effected in the form of sale and purchase in procedure.

There are two cases of unregistered transfers each of which is the case where the owner has neglected to register when he put the ownerfarm to tenant farm as he gave up farming. In the present survey, no instance where only the transfer of the right of tillage without any conbination in the ownership came to light.

(B) Revocation of tenant land.

The following table 24 shows the number of revocation of tenant lands from year to year, from which it is seen that the case of revocation is on the increase. In 1951, it reached a total of 35, but there must have been a considerable number of cases which did not come to light.

What is worthy of our notice is that the number of cases officially reported has increased. However, there were only 6 cases which were upproved. These

Table 24. Number of revocations (returning) of tenant farm.

Village	item	1949	1950	1951	Total
Hanawakawa	Registered transfers	—	5	3	8
	Unregistered transfers	2	3	5	10
Shibahira	Registered transfers	—	—	—	—
	Unregistered transfers	—	—	—	—
Nisattai	Registered transfers	—	—	5	5
	Unregistered transfers	6	1	3	10
Natsuta	Registered trnasfers	9	13	19	41
	Unregistered transfers	—	—	—	—
Total	Registered transfers	9	18	27	54
	Unregistered transfers	8	4	8	20

were the cases in which the contract of tenancy was cancelled by mutual consent of the parties concerned. There are 8 cases of revocation of tenancy which has become established facts though revoked without registering, being larger in number than those by law. Such revocations have delicate bearings with the character of the committee, so once revocation became a fact, it would be approved as resulting from the mutual consent of the parties concerned. On the contrary, in the case of contract on rent, the revocation of tenant land will hardly be approved when the dispute between the parties concerned is submitted to the committee. It should be pointed out here that there was no case of revocation without registering in Shibahira-mura and Natsuta-mura, in contrary to Hanawakawa-mura and Nisattai-mura. This is due to characteristics seen in the social structure of each village, of which some explanations have already been given in connection with the descriptions of land reform and recent problems arising from it in each village. Such revocation (returing) of tenant land are mostly caused in connection with the sale of the land or the charge of unreasonable tenant rent, so a few examples that came to light in the present survey will be given in the following.

(a) Hanawakawa-mura.

Table 25 shows the number of revocations of tenant lands in this village which became public questions. In 1951 and 1952, the landowners were successful in revoking the tenant lands. These landowners are those who had 2 to 4 *cho* of lands before the land reform, and, in consequence of the revocation of tenant lands, they now have more than 2 *cho* of land. In such a case as this, the landowners who have rented farms in addition to farm sufficient for their own cultivation, they are placed in a position to charge unreasonable rent or demand the tenant to

Table 25. Number of troubles and revokations of tenant farm in Hanawakawa-mura.

Year	Troubles	Revokations
1950	8	3
1951	5	5
1952	8	8

purchase it. Here are extreme cases of such instances.

a. The landowner O who formerly had about 4 *cho* of agricultural land was a reputable one, has come to cultivate only 9 *tan* through the land reform. Since then he has revoked his tenant lands, being now an ownerfarmer with 2.2 *cho*. From other tenant land, he charged and unreasonable rent corresponding to 5 *to* of rice per *tan*. He sold this tenant land in 1951 to another farmer without notifying the tenant of it and received the payment for it. In this dealing, he promised that the rent was to be paid to him who would hand it to the new landowner and that the land was to be turned over to the new owner when it became possible for O to revoke the land and get the consent from the tenant.

b. F sold a land under this own cultivation at 70,000 yen per *tan*. On this account, his acreage of cultivation was reduced, and in order to make up this loss, he revoked the tenant land without any remuneration.

c. G was a newly created ownerfarmer with 5 *tan* of land. On going to Hokkaido as a seasonal labor, he returned 3.5 *tan* to the former landowner and leased the remaining 1.5*tan* to another person.

d. H, because of labor shortage in his family, leased paddy field to two persons at money-payment of 7 to 8 *to* per *tan*.

As shown in the above examples, the tenant rent in this village in 2 bales of rice per *tan* in mountainous area where paddy fields are few, and in the every land it is paid in the sum of money corresponding to the price of one bale of rice supplied to the Government. In an extreme case 10,000 yen of rent per *tan* is paid. The rent for a rice-nursery is about 10% higher than that for the best class of paddy field and there was a case when 1 *koku* of rice was charged as the rent for only 10 *tsubo* of nursery, corresponding to the rent of about 3 *koku* of rice per *tan*.

In short, the land problem in this village seems to have been intensified, and changes in the class strate are caused by the possession and utilization of agricultural lands rather than by superiority or inferiority in their management.

(b) Nisattai-mura.

The social structure of this village is the least advanced among the villages under the present survey. It is perhaps on account of this that only a few cases were found in it where the tenant lands were revoked or unreasonable rents were charged. The cultivating lands in this village are low in productivity, consequently, in rent. The rent fixed by law was less than 600 yen for the best class of land. In sympathy with the landowners, the tenants usually furnished them with service labor of 3 to 5 persons per *tan* or pay a rent of 500 yen per *tan*. However, there was a case where three framers paid one bale of rice in addition to the statutory rent for 3 *tan* of paddy field under lease when the revocation of it was disapproved.

From the above description, it can be seen that the sharecroping tenant system which had been predominant in former days has not yet shown itself. As

to the service labor in addition to a regular rent, the labor rent seems to have revived in some quarters, but it is not forced by the landowner.

On the contrary, the situation is entirely defferent in the case of forestry and grass land. As described previously, the greater part of the forest is owned by merchants in the town of Fukuoka, who enjoy the same economic privilege as those resident in the village though in a different administrative area. Of late there has been a strong tendency to shut out the villagers from utilizing it which has been hereditary for years. Of course, they impose labor rent at will whenever necessary. In addition, a labor rent of 3 to 5 persons is imposed on them utilization of *yakibata kirikaebata* because they have not been opened to them as infinitive agricultural land. The acreage of such lands has been reduced in recent years, there are still about 30 farmers who lease such lands and they are fast seized with the sense of favor in their relation with the landowners. Because of the shortage of rearable lands, there are a large number of wage-earners who depend upon the forestry the slave-like woodmen and charcoal burners are still to be seen, and there are more than 40 farmers that are engaged in subsidiary work. The same is true of keeping cattle, about 20% of them being kept in trust. These means of production are commonly seen where they are owned by the same owner of the forestry, and the degree of dependence on him is so much the stronger. It is because the ban on the absentee landowners has not yet been removed that the tenant problem in this village is not so intinsified as in other villages. However, the fragmentary accurrence of revocation or purchase of tenant lands by the owner leads us to think that the same tendency as observed in other village will appear here a little later. How the committee who have endeavored to prevent transfers of farms will deal with such problems deserves our careful attention.

(c) Shibahira-mura.

No instances of conditions described above appeared in this village.

(d) Natsuta-mura.

In this village there are still 6 to 7 *cho* of tenant lands left, and there 15 to 16 landowners who demand a payment of more than the statutory rent and the rents on the whole seem to meet such demand. The definite sum is not known, but a rumor has it that there are some who pay the sum of money equal to 1 *koku* of rent of former days calculated in terms of rice supplied to the Government. This sum of money may be taken as the rent paid in other cases. It is worthy of our notice that the unlawful tenant rent in this village is paid in the form of moneypayment as in the case of Hanawakawa-mura though it is sometimes paid in the form of labor rent as in the case of Nisattai-mura. It is the small and medium landowners who failing to retain sufficient acreage of land for their own cultivation at the time of the land reform, demand unreasonable rents. They failed to revoke the tenant lands and now they demand "black"

rents. Consequently, the sale of the tenant land is often effected for the same reason as mentioned above.

Lastly, it must be said that it is due to the characteristic features in the social structure of each village and peculiar conditions in the relation between the parties concerned, but it must be due also to the character of the committee that the tenant land problems have appeared in different forms.

From the beginning, there were many problems which came to one way or other in solution, chiefly through the influence of the committee. Such a tendency became more apparent at the time when the agricultural land commission was changed to agricultural commission on the completion of the Government purchase (sale) of the lands and when the change in the personnal of the committee was carried out with a view to class idea recently, the committee shows a character entirely different to that shown at the time of its formation.

IV. Rate of Transfer of Agricultural Land.

1) The rate of transfer, classified according to paddy fields and upland fields, to owner-farms and tenant-farms and to with remuneration and without remuneration.

First, let us divide agricultural lands into paddy fields and upland fields, ownerfarms and tenant farms, and farms transferred with remuneration and those without remuneration, and see in which most transfers were effected,. In our survey, there was no case of the transfer of the right of tillage, so what will be explained in the following will be concerned with the transfer of the ownership of agricultural land.

(i) Rate between paddy fields and upland fields.

A comparison of the transfers of ownership of paddy fields and upland fields (Table 26) shows that the transfer of upland fields is largest in number in Nisattai-mura where the agricultural lands are mostly upland fields, whereas in other three villages, the transfer of paddy fields is largest in number. But if we look at the ratio between the transfer of paddy fields and upland fields in each

Table 26. Ratio of transfers between paddy fields and uplant fields.

Village	Number of transfers				Acreage of transfers			
	Number		Percentage		Acreage (in *se*)		Percentage	
	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
Hanawakawa	23	19	54.8	45.2	586	317	64.9	35.1
Shibahira	17	9	65.4	34.6	338	244	58.3	41.3
Nisattai	14	22	38.8	61.2	215	2,084	9.3	90.7
Natsuta	61	29	67.8	32.2	1,378	275	83.6	16.6
Total	115	79	59.3	40.7	2,511	2,918	46.3	53.7

Note : $1\ se = \frac{1}{10}\ tan$

village from the number and acreage of transfer, there is a considerable margin between them, and the total of all four villages indicate the transfer of field is larger in number but the transfer of paddy fields is larger in acreage, partly due to a peculiar condition existing in Nisattai-mura. In this village, the transfer of upland fields is, of course, larger in number, but even larger in acreage being more than 90 % was effected through instantaneous purchase by the Government. The acreage of transfer per case is different with paddy field and upland field, it being about 2 *cho* in field and about 2 *tan* in paddy field, which is only one-tenth.

As the instantaneous purchase practically has nothing to do with the actual transfer of lands let us return to Table 26 showing the whole transfers of paddy fields and upland fields, and we find that the transfer of paddy fields is larger than that of upland fields, being in the ratio of 71.2% to 28.8%.

(ii) Ratio of transfers of owner-farms and tenant farms.

By consulting with Table 27, we find that the transfers of paddy field are larger than those of fields both in number and acreage in all the villages except Hanawakawa-mura. The figures in the table show quite natural ratios as the

Table 27. Ratio of transfers of owner-farms and tenant farms.

Village	Number of transfers				Acreage of transfers			
	Number		Percentage		Acreage (in *se*)		Percentage	
	Owner farms	Tenant farms	Owner farms	Tenant farms	Owner farms	Tenant farms	Owner farms	Tenant farms
Hanawakawa	20	22	47.6	54.2	408	495	45.2	54.8
Shibahira	22	4	84.6	15.4	537	43	92.6	7.4
Nisattai	29	7	80.6	19.4	2,199	200	95.7	4.3
Natsuta	74	16	82.2	17.8	1,565	88	94.7	5.3
Total	144	50	74.2	25.8	4,709	726	86.6	13.4

ratio of the owner-farms to the whole agricultural lands in each village is predominantly great. However, the ratio shown here is the result obtained by comparing the absolute value of owner-farms or tenant lands one with another, so we shall have an entirely different picture of comparisons are made of the two with the all owner-farms plus tenant lands in each village. We shall explain it later. Only in Hanawakawa-mura, the transfers of tenant lands are larger both in number and acreage, but how and why so have already been explained in several sections.

(iii) Ratio between transfers with remuneration and those without remuneration.

Of the transfers of land applied officially, it was found on examination that there were cases where no money remunerations were given and cases where money remunerations were given. It is very diffecult to distinguish between the transfers with remuneration and those withoout remuneration as complicated

relation existed between the parties concerned. Table 28 is prepared from the data obtained by an actual survey of the cirucumstances without any regard to the prices given in the applications or to free gift.

Table 28. Ratio between transfers with remuneration and without remuneration.

Village	Number of transfers				Acreage of transfers			
	Number		Perceutage		Acreage (in *se*)		Percentage	
	With remu-neration	Without remu-neration	With remu-neration	Without remu-neration	With remu-neration	Without remu-neration	With remu-neration	Without remu-neration
Hanawakawa	32	10	76.2	23.8	595	307	65.9	34.1
Shibahira	7	19	26.9	73.1	91	490	15.7	84.3
Nisattai	30	6	88.3	11.7	2,104	195	91.5	8.5
Natsuta	41	49	45.5	54.5	352	1,301	21.2	78.8
Total	110	84	56.7	43.7	3,138	2,263	57.5	42.5

In Hanawakawa-mura and Nisattai-mura, the transfers with remuneration are larger in number and acreage, but in Shibahira-mura and Natsuta-mura the transfers without remuneration are larger. In all four villages, the transfers with remuneration are slightly larger in number and acreage.

Here, too, the instantaneous contract played a disturbing part, and if it is taken out of consideration, the ratio of the transfers of land effected without remuneration or at the price around that fixed by law is greater in every village except Hanawakawa-mura where a special farm of sale and purchase of agricultural lands was effected.

It was quite natural that the transfers of tenant lands were effected in the farm of sale and purchase with remuneration, the transfer in the form of free gift being done in very few cases. In Hanawakawa-mura, the transfers of tenant lands were larger than those of owner-farms, a fact worthy of our attention.

In the preceding section, we have considered the transfers of lands by dividing them into three items and tried to see in what kind of agricultural land the transfer was largest in number. Table 29 gives the result of the survey by combining the

Table 29. Greater transfer in number or acreage in each village.

Village	Paddy field (A) and upland field (B)	Owner-farm (C) and tenant-farm (D)	With remuneration (E) and without remu-neration (F)
Hanawakawa	(A)	(D)	(E)
Shibahira	(A)	(C)	(F)
Nisattai	(B)	(C)	(E)
Natsuta	(A)	(C)	(F)
Total (four villages)	(B)	(C)	(E)

ratio of the transfers whichever graeter in number or acreage in each village.

Taking Hanawakawa-mura for an example, it will be seen that here the transfer of pady field is larger in number, and of the pady field transferred, the tenant land is larger in number and that with remuneration.

2) Ratio of agricultural lands transferred.

(i) Ratio of farm houses involved in the tansfers of agricultural land.

Table 30 shows the ratio of the farm houses involved in the transfers of agricultural lands to the total number of farm houses in each village. It can be

Table 30. Ratio of number of farmers concerned with transfer to whole farmers.

Village	Ratio to whole farmers in village	
	Farmers lost land	Farmers gained land
Hanawakawa	4.17%	6.42%
Shibahira	2.99	2.99
Nisattai	4.11	5.68
Natsuta	7.89	8.44
Total	4.89	6.02

seen from the table that a large number of farm houses became involved in the transfer of agricultural land in a year, and in Natsuta-mura it was over 10%. Of the number of farm houses involved, about 5% effected the transfer with remuneration, but it was only 1% in Shibahira-mura. The ratio is obtained by comparing the total number of farm houses involved in the tansfer of land with that of the whole farm houses in the villages, and it is certain that there are among the farmers involved those which have lost either the ownership or the right of tillage and in rare cases those which became involved in both. By comparing the actual number of those which became involved either in the transfer of ownership or that of the right of tillage with the total number of farm houses, it was found that the number became less than in the case of comparing the total number, and that the difference in each village showed itself alternately. Suppose we make a total for four villages, the ratio of those which have lost the ownership or the right tillage to the total number of farm house is found to be 4.89%, and that of those which have gained them is found to be 6.02%, showing a difference of 1.13%. This difference is the difference in the number per house which has lost and which has gained them ; in short it indicates the fact that an agricultural land one house is forced to sell is purchased by a certain number of houses in divided shares. However, in Shibahira-mura, the ratio is the same for both cases.

(ii) Ratio of acreage of farm transferred to total acreage of farm.

There is a rumor that the transfer of agircultural land has been effected extensively since the control on the price of agricultural land went out of

enforcement, but the present survey of the transfers in 1951 shows that the number of transfers for that year, though it includes that for preceding year, is not so large as expected ; it is due to the following reasons.

First, although practically no restriction had been in force on the transfer of agricultural land since the latter half of 1950, farmers were not aware of it, and especially farmers in the Tōhoku Region are apt to think even now that all transfers are effected in "black market", because they have been subjected to a very rigid restriction there.

Second, what is still more important is that holding a large area of land has become insignificant economically. In those days when the transfer of land was effected under free competetion, the high rate of tenant rent on the spot was the motive behind the concentration of lands, and the price was fixed under these conditions. The rate of tenant rent, however, is still kept low under a control, and there was no case in the present survey, where agricultural land had been purchased with a view to making a living on the rent, all the transfers being effected for the purpose of getting owner-farms.

Thus the transfer of agricultural land for the year under the present survey was effected in a limited frame, the ratio to the total acreage being only 1%, as shown in Table 31. The ratio of the transfer in the farm of sale and purchase was

Table 31. Ratio of acreage of farm transfered tor whole acreage of farm.

Village	Ratio to whole acreage of farm	
	Total acreage of farm transferred	Acreage of transferred with remuneration
Hanawakawa	1.14%	0.76%
Shibahira	0.55	0.09
Nisattai	4.09	3.70
Natsuta	1.48	0.31
Total	1.54	0.89

still less, being less than 1%. The ratio for Nisattai-mura was quite great because of the presence of the instantaneous contract, but the ratio will approach those for other three villages if we leave out the instantaneous contract. If we do so, there will be a great difference between this ratio and that for the number of farm houses involved in the transfers observed preveously, but it must be due to the fact that the acreage transferred per house or per case is extremely small.

This will be made clear from Table 32. In Hanawakawa-mura, we found an extreme case where one farm house sold the land to 12 farm houses, a share per house being only 2 *tan*. So, apart from the instantaneous contract with the Government, the acreage transferred per house is about 3 *tan* and usually the acreage gained is smaller than that lost.

Table 32. Acreage of farm transferred per house and per case (in *tan*).

Village	Acreage per house		Acreage per case		
	Lost	Gained	Average	Owner-farm	Tenant farm
Hanawakawa	4.1	2.5	2.1	2.0	2.2
Shibahira	2.6	2.6	2.2	2.4	1.1
Nisattai	10.1	7.9	6.4	7.6	2.9
Natsuta	2.8	2.7	1.8	2.1	0.5
Average	4.3	3.5	2.8	3.3	1.4

Let us next examine into how the ratio of each owner-farms and tenant farms transferred stands with ratio respectively of total acreage of each owner-farms and tenants-farms in the villages. On comparing the absolute quantity of the acreage of owner-farms transferred and that of tenant farms, we found the owner-farms to be far greater, the ratio almost corresponding to that of the acreage of owner-farm and tenant-farm in each village, as pointed out previously.

As seen from Table 33, the ratio of each owner-farms or tenant-farms transferred to that of the whole owner-farms or tenant-farms in each village is reverse to the previous case. That is to say, the relative ratio of the tenant farms transferred is remarkably higher than that of owner-farms, and it seems the transfer of tenant farms is more-easily effected than owner-farms.

Table 33. Ratio of acreage of owner-farms and tenant farms transferred by sale and purchase to whole acreage of each farms.

Village	Acreage of owner-farms transferred by sale and purchase	Aacreage of tenant-farms transferred by sale and purchase
	Whole acreage of owner-farms	Whole acreage of tenant farms
Hanawakawa	0.28%	4.97
Shibahira	0.07	0.14
Nisattai	5.88	1.47
Natsuta	0.29	1.35
Average	0.79	1.62

V. Factors for the Transfer of Agricultural Land.

1) Reasons for giving up agricultural land.

Instances obtained in the present survey are insufficient in number to enable us to deduce a general tendency concerning the cause for the transfer of lands. In addition, in making statistics, something undesired entered, such as a particular circumstances intentionally enphasized or neglected.

Furthermore, when the replies to a question concerning the reasons for the transfer of land were plural in number they were put under the respective items according to the prearrangement of the survey, so it is difficult to grasp the primary reason for it. This must be kept in mind. A mention also must be made

of the fact although the statistics was made of the transfers according to the class of farmers involved in the transfers because of the very nature of the problem, the judgement of the class was made primarily on the basis given Table 34, but not strictly on it, determining it for each village by taking into account various conditions found in it.

Table 34. Basis of classfication of farmers.

Classfication	Award income (1950)	acreage of cultivating farm
A (lower class)	less than 10 thousand yen	less than 1 *cho*
B (middle class)	10–20	1–2
C (upper class)	more than 20	more than 2

(i) General reason for the sale of agricultural land.

Table 35 shows the replies to the question "What is the general reason which has caused you to sell the agricultural land. In making a total of the replies from four villages, it is seen that the "need of money" is largest in number, being 62 in all. However, this is not common with each village or each class, some difference existing between them.

Table 35. Classfication of cases by general reason for the sale of farm.

Item / Class	No special reasons (8)	Labor shotage (9)	Need of money (10)	Unpayment by low rent (11)	Unpayment by tax and others (12)	Unpayment by delivery to Government (13)	Requesting of purchaser (17)	Tenant-farm unreleased (8)	Other reasons	Total
A	7	—	26	—	—	—	1	3	7	44
B	4	3	18	1	3	—	2	3	25	59
C	6	5	18	2	5	1	3	2	23	65
Total	17	8	62	3	8	1	6	8	55	168

According to social class "need of money" was overwhelmingly large in number among those in A class but "other reasons" than "need of money" was large in number among those in B and C class. "Other reasons" which are seen in the following tables together with "no special reason", involves the greater part of transfers without remuneration concentrated mostly in the upper class of farmers such as division or combination of the land or free gift if "other reasons" is excluded. On the contrary, such transfers cannot be seen among the lower class. Consequently, A in the lower class gave up his land because he was in need of money, while B and C in the upper class gave up theirs for reasons other than need

of money in most cases.

According to the grouping by village, "need of moeny" was overwhelmingly large in number in Hanawakawa-mura and Nisattai-mura where a large number of transfers was effected with remuneration; on the contrary, "other reasons" was large in number in other two villages where the transfers were effected mostly without remuneration, which was quite natural.

There was no instance in A class where the sale was positively effected in consideration of calculated profit due to "shortage of labor" and to items 11 to 13 but it increased in number in the ascending order of B and C class, showing a tendency quite opposite to that among different class shown in the stance where the transfers were negatively effected not from the "need of money".

There are six cases where the transfers were effected "at the request of purchaser" but whether they were or not cannot be ascertained because there is no item called "request made to seller" in the table of results obtained from the "general reason for the purchase" of land, the other side of the contract of transfer. To speak contrariwise, it is nearer to the truth to say that the transfers were effected for the reasons "asked by seller" and "for fear it may be sold to the other" given in Table 39. It is a delicate problem that there was no instance where the transfer was effected because it was "high time for sale with good price fixed on the land".

(ii) Reason for need of money in payment of particular expense.

Table 36 gives the replies to the question "Was sale necessitated by the payment of particular expenditure", that is, on what the proceeds from the sale were spent.

Table 36. Classfication of cases of selling farms by reason for paticular expense.

Class	No special (20) reasons	Housholding expenditure				Clearing off old debts	Inheritance tax	Managing expenditure			Subsidiary expenditure		
		General expense	Medical expense	Marrige expense	Schoolarship			Implement expense	Live-stock expense	Repairing hous expense	Others	Funds of subsidiary work	Others
A	14	6	—	2	—	19	—	1	—	—	1	—	—
B	31	2	3	1	1	2	—	1	—	3	—	—	9
C	31	1	2	—	—	6	5	1	1	10	1	3	7
Total	76	9	5	3	1	27	5	3	1	13	2	3	16

The table may be regard as explaining in detail the substance of the reason "need of money" item by item, if "no special reason" and "other reasons" are excluded as in the previous case.

The largest in number is the cases of "clear-off of old debt", being 27 in all, of which 70% (19 cases) falls in A class. Next largest in number is 18 cases of "houshold expendetures" of which 8 cases fall in A class. Consequentry 27 cases out of 29 in A class will in the class of sale effected for negative unavoidable reason. On the contrary, there is only one case where the sale was effected in order to have complete farming facilities, and all others are limited to B and C class. Especially in C class, "for construction and repairs of houses" was large in number. "Construction and repairs of houses" include not only the houses of their own but also those for branch families. Speaking branch families, it is strange see 14 cases in A class which gave up the lands without any particular reason, but in most cases it was done in the form of free gift to their brach families, a fact worthy of our notice in that it shows the pressure of overpopulation extending even to the lower class.

Among the reasons given for the sale of farm in B class there are many cases where housholding expense, particularly medical expense was necessary, while in C class, the sale was effected to clear off old debts or to pay inheritance tax. There are many cases in B and C classes where they have fallen to a lower class through the payment of such expenses as these for they have nothing in reserve economically.

(iii) Reasons due to some connections with agricultural land given up.

The question given in this connection was "Was there any reason for selling that particular land ?" Of course, the land was not sold for that particular reason only, but for various circumstances described in the preceding section. It is seen from Table 37 that the case "it mignht be as well to sell land other than that particular land" was largest in number, 48, followed by 38 cases of "the buyer is the tenant and other connections with the buyer", and this tendency is common with each village and each class.

Table 37. Cases of sales owing to land conditions.

Class	Number of farms investigated	No special reasons	Low fertility	Long distance	Rented farms or other relations	Others
A	22	20	5	4	12	4
B	46	35	2	5	11	4
C	46	29	1	6	13	7
Total	112	84	8	15	36	15

There are many instances where the landowner gave up his land on the inferiority of fertility of the land viewed from "fertility of land" and "distnce". To speak contrariwise, there were a equal number of buyers there who were not in a position to select the lands according to their fertility.

In the above statement explanations have been given as to the reasons why

they gave up agricultural lands, but it is impossible to make clear from the present survey which of them is the primary reason for such a sale. By putting together various considerations of the reasons given in the present survey, they can be classified into the more negative (consumptive) unavoidable in nature and the more positive (productive). Of the two, the former is larger in number, and when viewed from the social class the former is larger with the lower class and the latter is confined mainly to the upper class.

2) Reason for purchasing the ownership of the land.

(i) General circumstances pertaining to the pruchase of land.

Table 38 gives the replies to various questions on this. There are 6 cases of pruchase on the base of so-called "sale and purchase", but this also can be clas-

Table 38. Cases of farm purchaseings classfied by general reasons.

Class	No special reason (1)	Surplus of labor (2)	Consider-ation of investment (3)	Request of the seller (4)	Afraid of sold to others (5)	Through free gift (6)	Land consolida-ting (7)	Others (8)
A	5	6	4	11	4	22	2	5
B	6	5	3	13	3	9	9	7
C	—	1	—	8	1	4	6	1
Total	11	12	7	42	8	35	16	13

sified into positive purchase and negative purchase. 19 cases with the reason (2) and (3) may be regarded as belonging to the former and 50 cases with the reason (4) and (5) to the latter. The cases of negative purchase is overwhelmingly large in number, which is common with each village and each class and which is similar to the case of sale. Even though the purchase might be effected at the request of the seller (4) or for fear it might be sold to other one (5), the nature of the purchase must be different as to whether the land is owner-farm or tenant farm, and the parts played by the seller and the purchaser will be reversed. Consequently, even though a purchase may be of negative nature, most instances of tenant farms "being forced to buy" are to be found in the lower class and most instances of owner-farms "being forced upon them to buy" are to be found in the upper class. Many cases of positive purchase for "surplus of labor" (2) or for "in consideration of investment" (3) are found in the lower class. Even though they have got the possesion of land by the positive purchase, it was meant to expand their owner-farms to a point where their family labor efficiently available, and not to shift capital funds from other industry. We shall explain this in detail in the section dealing with the purpose and the price of land pruchased.

There are many cases where agricultural lands were made accessible through free gift, especially in A class. Such cases are found in large number in Shibahira-mura and Natsuta-mura, perhaps beacuse these two villages have

comparatively favorable economic conditions. Of the purchases done for "surplus of labor", many are the instances where the purchases have been effected in anticipation of branch families to be created in future.

(ii) Reason for purchasing a particular land.

Of the reasons "why the particular land was purchased", 45 cases are "because it was the land they cultivated under tenant contract" (Table 39). Of 45 cases, 25 belong to B class (55%), the greater part being the transfers with the whole

Table 39. Cases of purchasings owing to land conditions.

Classes	Number of farmers investigated	No special reason	Low fertility	Long distance	Land consolida-ting	Leased land	Through gift	Others
A	56	19	2	7	5	16	14	1
B	56	14	1	9	11	25	5	3
C	18	2	2	6	5	4	5	3
Total	130	35	5	22	21	45	24	9

sum of remuneration. The case is large in A class, too, but not so large as in B class, and it becomes quite less in C class. This is closedly connected with the ratio of the agricultural lands cultivated by each class on the basis of owner-farm and tenant farm, and also to the conditions under which the funds necessary for purchases were financed. Since the right of tillage still remains to be unstable, the desire for the posession is intensive, and main reasons for it is to be found in various social conditions existing in a particular piece of land, not in the "distance" or "fertility" of the land.

VI. Transfers of Agricultural Lands between Different Social Stratas

As stated previously, there was clear differences in the reasons for the transfer of land between classes. Let us now see how the transfer was effected in each

Table 40. Classfication of cases of transfers in each village by farm class.

Village	Item	A	B	C	Total
Hanawakawa	Lost	10	7	6	23
	Gained	15	13	8	36
Shibahira	Lost	1	13	5	19
	Gained	9	13	—	22
Nisattai	Lost	6	8	6	20
	Gained	10	9	—	19
Natsuta	Lost	5	18	27	50
	Gained	22	21	10	53
Total	Lost	22	46	48	112
	Gained	56	56	18	130

class.

Table 40 gives the number of transfers effected, conveniently divided into those lost and those gained. There were 242 cases of transfers in the four villages, those in B class being largest with 102 cases, followed by A and B class in the order named. There were 112 cases where the lands were given up, B class standing at the top with 46 cases, followed by C class with 44 cases and A class with less than a half of the number of cases in either B or C class.

As to the number of the cases where lands were gained, A and B class are the the same in number, and in C class the number of transfer is less than one-third of A and B class. Table 41 shows the results obtained. From this table it is

Table 41. Percentage of farm land lost and gained.

Item	A	B	C	Total
Lost	19.6	41.1	39.3	100.0
Gained	43.1	43.1	13.8	100.0
Lost	28.2	45.1	70.9	
Gained	71.8	54.9	29.1	
Total	100.0	100.0	100.0	

seen that in A class, the number of those who gave up lands was 30%, and those who gained them was 70%, but in B class, the number is exactly reverse. Therefore, there must have been a change in the possession of lands between A and B class, equal to the difference between the numbers of transfers effected in the both class. There were many changes in the possession of lands in B class, but actual changes in the acreage of transfers were cancelled with one another, largely through influences coming, from the similar changes in A and B class.

Table 42 shows the modes in which the transfers in the form of "sale and purchase" were effected between different class. Here again A and B class

Table 42. Cases of transfers by farm of selling and purchasing between each class.

	Cases of purchasing			
class	A	B	C	Total
Cases of selling A	10	6	5	21(9)
B	3	9	0	12(10)
C	9	7	2	51(30)
Total	22(22)	22(22)	7(7)	51(30)

Note : ( ) = farm hous.

are the same in the number of purchases of lands, but C class has less then one-third of the number of cases in A and B class. In the number of sale of land, A class comes at the top, followed by B and C class in the order named, which is

entirely reverse of the order B, C and A class given in the preceding table. However, looking at it from the number of houses involved, the order is changed to C, B, A class and approaches the order in the preceeding table. Consequently, it is seen that A class made the least sale and the largest purchase of land, whereas C class made the largest sale and the lesst purchase of land, confirming the results given in the preceding table. It is to be noticed that in B class the number of purchases is considerably small as compared with that of sales. It must be pointed out that the class shown in these two tables represent the states of changes in each class realized by the transfers of lands, for the tables were both made as of the time the present survey was carried out. Consequently, the actual state at the time of the transfers can be had by either adding or substracting the acreage of transfers to or from the sellers or buyers. Here we shall not go to this trouble, but, at any rate, the number of the sellers in the lower class will be reduced so much and it will be increased so much in the upper class, the case being reverse in the case of purchasers.

Therefore, the tendency given in the two preceding tables of the transfer of lands from the upper to the lower class will be more remarkable, if they are made on the conditions existing at the time of actual transfers. We shall explain them by taking a concrete example.

Of the number of sellers in A class, the largest was 14 cases in Hanawakawa-mura, of which 12 cases were those of the K family who was forced to sell all his lands, about 2 *cho*, in order to clear off the debts from the agricutural co-operative association. Looking into the actual conditions existing at the time of the transfer it is seen clearly that the K family properly belonged to C class, and the 12 cases in the number of sales in A class should be added to that of C class. In short there were only two cases of sales in A class, in Hanawakawa-mura. It is worth noting that there are 7 cases of purchase in C class, but 4 cases are those of purchases of the lands belonging to the K family, forced by the decesion of his relatives. Another family purchased merely the title of the tenant farm. After all, there are only two houses in the all four villages which purchased owner-farms and expanded positively their agricultural land.

The fall in C class and rise in A class are the two things which stand out in the present survey, but the changes in B class which is supposed to be the standard farmer are also very suggestive and cannot be made light of. In this class, the sellers of lands are much greater in number than the purchasers, but hardly any transfer between this class and other class can be seen, it being effected among themselves.

Let us now consider the conditions from the groupings according to the size of the lands under cultivation. Table 43 gives the number of the farm houses which sold the land, based on the groupings according to the size of farms under cultivation after the transfers (July 1, 1952).

Table 43. Cases of transfers classfied by farm size.

		Less than 5 *tan*	5–10	10–15	15–20	20–25	25–30	More then 30	Total
Farmers gave up the land	Total farmers	2	15	25	21	26	15	5	109
	Percentage	1.8	13.8	23.0	19.2	23.8	13.2	4.6	100.0
	Farmers sold the land	2	9	6	5	9	2	1	34
	Percentage	8.5	25.7	17.2	14.3	25.7	5.7	2.9	100.0
Farmers gained the land	Total farmers	11	23	42	27	14	8	2	127
	Percentage	8.6	18.1	33.0	21.4	11.0	6.3	1.6	100.0
	Farmers purchased the land	4	5	23	12	6	2	1	53
	Percentage	7.6	9.4	43.3	22.7	11.3	3.8	1.9	100.0

The number of farm houses that gave up their lands is the largest in the backbonefarmers with 1 to 2.5 *cho* of agricultural lands, growing less in both the upper and lower class. The number of sales with remuneration is not so large in the class with 1 to 2 *cho* of land as in the previous case, bieng mostly in the class with 5 *tan* to 1 *cho* of land. The number is considerably large also in the class with less than 5 *tan* of land.

The farm houses that gained the land are to be found mostly in the backbone class, being larger in number than those who gave up the land. The number, however, is somewhat concentrated in the lower class. The concentration in the hands of the class with 1 to 1.5 *cho* of land was as intensive as in the case of purchase, showing the strong desire to get possession of land of the class. The farmers with more than 2.5 *cho* of land are a few in number in the purchase of land, but large in the class with less than 1 *cho* of land.

In the above, we have considered the absolute number of farm houses involved in the transfer, but the situation will be slighty different if we consider the number of farm houses involved in contrast with the distribution of farm houses on the size-group of the farm houses. That is to say, the concentration in the hands of the backbone farmers, seen in the comparison of the absolute value

Table 44. The conditions of farm management

Class	Farmers		Farmers engaging subsidiary works		Amount of award income (1951) (in thousand yen)		Acrcage of holding land	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
A	21	54	5	17	94	82	9.3	8.4
B	46	56	7	7	127	141	16.1	15.2
C	48	18	5	1	215	251	25.9	24.8
Total (Average)	111	128	17	25	156	135	18.7	13.6

Note : (a) = farmers who gave up the land. (b) = farmers who gained the land.

of the number of the houses involved, is alleviated to a large extent, because the ratio of the farm houses involved in the transfers in the upper and lower layers in creases and the ratio of those in the backbone class decreases. It is very difficult, however, to make clear the degree of changes in this class, because there few instances of changes, and because changes in both owner-farms und tenant-farms are included in it although the tendency of the concentration in the hands of the backbone lager is apparent. The influence of such changes must have been weak because they are so small in number and acreage.

Finally, Table 44 shows the actual state of farm management by farm houses in each layer used as reference in making class judgement of houses in the present survey. As seen from the table, it can be confirmed that the farmers who have sold lands enjoy more favorable conditions in every respect than those who have purchased them even after the completion of transfers of lands. Even now the former own about 1.6 *tan* of land for lease and the latter 6 *se* of leased land. Moreover, there is a margin of 3.4 *tan* of land between the cultivated acreage of the two. The margin must have been still greater before these changes.

There were one or two houses in each village which could not be surveyed because they had left the village before the survey or absent on some outside labor at the time of this survey. Although they are excluded from the statistics, they belong to the layer of sellers, namely, B or C class. Those who have purchased lands belong to B class, which, together with those have fallen from C class and those who have risen from A class, tends to raise the standard. Impressions that each surveyor got from his studies may be summarized as fallows: The changes observed in 1951 represents the stage in which confusions in each class strata in the social order caused by the land reform was about to be adjusted, which it was impossible at the time of the present survey to grasp as to how it would envolve, and it can be done only by the observation of large numbers of instances over a long period of time in the future. However, it was a fact common with all the four villages that the changes, far from decreasing, tended to increase rapidly in number.

of sellers and purchasers (1952).

Acreage of cultivating land		Acreage of Forest and grass land		Number of family members		Number of family laborers		Number of regularly hired laborers	
(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
·· in tan ····· →				← ····· per farm hause ····· →					
8.2	9.1	25.2	7.0	7.0	5.7	2.1	2.4	0.05	—
15.0	15.5	8.2	7.2	7.2	7.6	3.1	3.2	0.07	0.05
24.1	23.7	18.3	8.0	8.0	8.0	3.2	3.2	0.05	0.11
17.3	13.9	15.4	7.5	7.5	7.5	3.0	2.9	0.05	0.14

VII. The Price Charged for the Sale or Purchase of Agricultural Land

The control on the transfer and sell and purchase of agricultural land is almost out of enforcement, but it is still in force on the collection of tenant rent and the possession of land over and above the limit fixed by law. In view of the above circumstance, it is quite natural that the transfer of land is effected in a limited extent and that the price of land is fixed by peculiar circumstances existing between the parties concerned.

Of the results obtained from this survey, some differences may be observed between the selling prices and buying prices in some instances. They are due to the fact that there were cases where surveys could not be made in either the selling prices or the buying prices, which caused disagreements in the number or acreage of transfers, but they are not the difference produced in the prices, so to speak, of double dealing. Therefore, it is right to consider either the selling price or the buying price, here we take the selling price for an example.

Table 45 gives the instances of actual sale, dropping out those perfunctory sales without money remuneration. First of all, it is a common tendency in each village

Table 45. Price of farm land sold (per *tan*).

Village	Kind of field	Sale the owner-farm			Sale the rented-farm	
		As others owner-farm	As other utilization	As to instantaneous sale to Government	To fomer tenant-farms	To others
		yen	yen	yen	yen	yen
Hanawakawa	Paddy field	40,946	—		24,401	—
	Upland field	9,525	—		8,333	16,022
Shibahira	Paddy field	22,894	—		3,566	—
	Upland field	19,402	—		—	—
Nisattai	Paddy field	—	—	2,161	57,851	—
	Upland field	15,202	—	775	27,510	—
Natsuta	Paddy field	57,216	51,950	3,339	44,633	—
	Upland field	—	22,550	928	22,810	—
Average	Paddy field	41,184	51,950	2,695	30,007	—
	Upland field	14,358	22,550	795	11,543	16,022

that the sale of paddy field is effected at a price almost double or tremble that of fields. On an average in four villages, paddy fields are sold at 40,000 yen per *tan* and fields at 12,000 yen per *tan* in the case of owner-farms. Paddy field and fields are higher in price in the case of owner-farms than in the case of tenant-farms. This difference in the total of all the four villages were, on an average, about 10,000 yen in the case of paddy fields and about 3,000 yen in the case of fields. This difference appears differently with the area and time and in degree. Here we point out three points to be noticed about it.

(i) The first thing to be noticed is that this difference is not attributable to

natural grade or fertility of the agricultural land as in former days, but to particular relations existing between the landowner and tenant. That is to say, the selling price and the buying price fluctuate in response to the surplus or shortage in the acreage of cultivation around the level fixed by the effective wiehgt of both landowner and tenant. For example, when the influence of the landowner is extremely strong, the revocation of tenant farm becomes general (the case of Hanawakawa-mura previously stated) and a price higher than that of owner-farm must be affered in order to guard the land under his cultivation (the case of Nisattai-mura given in Table 45). Such a tendency is growing in force even in Natsuta-mura where the farmers' organization has grown powerful.

(ii) The next thing to be noticed is that there was no instance of purchase for the purpose of collecting the tenant rent, that is, the purchase for the purpose keeping it under lease with the seller or keeping it under lease with a third party, to speak contrariwise, the sale under a promise to keep on cultivating the land. This was perhaps because the tenant rent fixed by law is considerably low as compared with the selling or buying price. Thus, there were only two farms of getting owner-farm, either to maintain negatively the land under cultivation by purchasing the ownership of the land, or to expand the land under cultivation purchasing the owner-farms. How strong their desire to get lands for their own cultivation was can be seen in their replies to the question "Can you make profit out of a purchase of land as owner-farm ?". Of 83 farmers, with the exception of 54 whose answers are unclear, 72(86%)answered"*yes*" subjectively, of not objectively.

(iii) The third thing to be noticed is that the so-called "the right of tillage" is not established as a practice in the villages surveyed. The difference in the price at which the owner-farm or tenant farm is sold or purchased may be said to represent the price of the right of tillage ; on the other hand, there are instances, as in Nisattai-mura, where the price of the tenant farm is higher than that of the owner-farm (refer to the preceding table), and no cases are observed where the right of tillage alone is transferred without any change in the title. There were two instances in Natsuta-mura where a revoking fee was paid at the occasion of revacation of land. In addition to the regular price a sum of 10,000 yen per *tan* was paid to the tenants when the land was sold as a school site. In extreme cases, the landowner sold the title to a third party without giving any notice to the tenant. For these reasons, it was impossible for us to deduce from the results of our survey some sort of rule regarding the right of tillage.

Table 46 shows the distribution of the selling and buying price of paddy fields and fields according to the groupings of owner-farm and tenant farms. It is seen from the table that paddy field were either sold or purchased at 30,000 to 50,000 yen per *tan* in most cases and fields, both owner and tenant, at 10,000 to 30,000 yen per *tan* in most cases. By far, the largest number of sales and pruchases of paddy field and fields under tenancy is to be found in the area where the price of

Table 46. Cases of transfers classfied by price (in thousand yen)

	Kind of field	Owner or tenant	Lower than 1	1–3	3–5	5–7	7–9	Higher than 9	Total
Total of 4 villages	Paddy field	Owner field	—	7	5	5	2	1	20
		Tenant field	3	2	11	2	1	—	19
	Upland field	Owner field	—	7	1	—	—	—	8
		Tenant field	6	8	3	—	—	—	17

such lands as lower than that of owner-farms.

As seen in Table 47, the highest price charged for paddy field was 97,000 yen per *tan*, but it was the price of nursery calculated in price per *tan* of paddy field. The price was lower as the land transferred was larger in acreage. The price per *tan* was not so high as we expected as the lands transferred were less in acreage than we expected.

Table 47. The highest price charged for sale of land per *tan*.

Villages	Paddy-field	Upland field
Hanawakawa	95,700 (O) yen	23,308 (T)
Shibahira	62,500 (O)	19,400 (O)
Nisattai	79,000 (T)	48,800 (T)
Natsuta	86,100 (O)	45,000 (T)

Note : (O) ≒ Owner-farm. (T) = Tenant-farm.

However, the price at which the transfer of lands was effected tended to rise, especially in the villages near towns and cities. For example, villages around the twon of Mizusawa, Iwate Prefecture, adjacent to which Natsuta-mura is located, are said to the zone where the transfer of land has been effected vigorously, and there are many among small scale farmers who sell their farms as residential sites at a price, say, of 2,000 yen per *tsubo* (1*es*=30 *tsubo*). This lead other farmers to do the same thing, which regulate the price at which such a transfer of land is effected. In Natsuta-mura, the price of agricultural land was higher than in any other village, especially for the land sold for purposes other than farming, the price was, on an average, over 50,000 yen per *tan*, probably due to the circumstances mentioned above.

VIII. Transfer of Land and Financing

1) How to raise fund necessary for the purchase of agricultural land.

How do farmers raise fund when they want to purchase agricultural land? As seen from Table 48, funds borrowed were greater in bumber than their own funds in all four villages. However the borrowed funds include the instantaneous transfers with the Government, which have nothing to do with the financing of

Table 48. Cases of raising funds necessary for purchase of land.

Village		Number of farmers Investigated	Cases of purchasing by own funds				Cases of purchasing by funds borrowed from others		
			Total	Cash on hands	Diposits drawed	Total	Government	Friends	Others
Hanawakawa		21	12	8	4	9	—	7	2
Shibahira		6	3	3	—	3	—	3	—
Nisattai		20	5	5	—	15	10	5	—
Natsuta		24	9	7	2	15	8	2	5
Total	Cases	71	29	23	6	42	18	17	7
	Percentage	100.0	40.8	32.4	8.4	59.2	25.4	23.7	9.9

Note; ( ) = Number of cases borrowed

the purchase. If they are excluded, the number of farmers who did not make use of the borrowed funds is greater than that of those who used them.

Of their own funds, cash on hands is overwhelmingly large in number, and there were very few cases of drawing deposits from banks. There was only one case where deposits were drawn from the co-operative association. When farmers want to purchase in order to expand their farms for cultivation or when the upper class farmers purchase the ownership of tenant land, they do it by means of their own funds ; when lower class farmers are forced, by such pressing circumstances as "requested by the seller to buy" or "for fear that it may be sold to a third party", to purchase the ownership of the tenant land, they usually borrow funds from others, as clearly seen from Table 49. At any rate, no instance was found where the funds were borrowed from others to purchase land with a view to making an investment of money , most cases being effected with funds raised negatively.

Table 49. Number of farmers borrowed the funds or not.

Class	Farmers no borrowed	Farmers borrowed
A	11	12
B	13	9
C	5	3
Total	29	24

2. Where did they borrow the funds from and how much ?

As seen from Table 50, the case of borrowing funds from friends is overwhelmingly large in number and in acreage of lands purchased with them.

On the contrary, there was no instance where funds were borrowed from banks or private money lenders, showing how farm financing is going on at present in farm villages.

As to the sum of loans, it may be said that the funds borrowed from friends or the cooperative association were very small in sum as compared with the price to be paid for the land, with the exception of those from the association for mutual

Table 50. Amount of funds for purchasing the land classfied by creditors.

Village	Agric. co-ope. Association	"Mujin" (mutual loan association)	Friends
Hanawakawa	(2) 12,500 yen	— yen	(7) 40,000
Shibahira	—	—	(3) 21,000
Nisattai	—	—	(5) 23,000
Natsuta	(3) 17,133	(2) 80,000	(2) 105,000
Total	(5) 76,900	(2) 160,000	(17) 668,000
Average (per case)	15,280	80,000	39,294

financial aid. Therefore, it is very probable that in most cases they finance their purchases mostly with cash on hands, deficiency being filled with the funds borrowed from their friends, for it is impossible to do so with such a small sum of funds available from their co-operatives or friends. We could not make clear the ratio between the two in the present survey.

(i) Agricultural financing and agricultural co-operative association.

Of the agricultural co-operative association surveyed, those in Natsuta-mura are the only ones doing works worthy of them, others being in aparalyzed state, as has been stated in the description of Natsuta-mura. In this section, a consideration will be made of the part played by the agricultural co-operative association in each village in agricultural financing.

Those who have utlized them to raise funds are very few in number, and the funds loaned are very small in sum as compared with the price charged for agricultural land. Even in the case where the transfer was effected with their own funds, there was only one instance throughout the four villages where they drew deposits from the association.

The principal factor responsible for bringing about such circumstances as mentioned above is the inactivity on the part of credit section of the co-operative association. As seen from Table 51, the sum of loans has tended to increase

Table 51. Amount of savings and loans of agricultural co-operative associations (in thousand yen).

Villages	Year and date	Saveyings	Loans	Agric. bills
Hanawakawa	6.1. 1951	6,176	7,444	3,337
	6.1. 1952	4,640	10,515	6,589
Shibahira	6.1. 1951	4,697	5,271	4,920
	6.1. 1952	2,331	1,188	921
Nisattai	6.1. 1951	1,003	45	—
	6.1. 1952	1,276	424	—
Natsuta	6.1. 1951	14,175	9,033	8,408
	6.1. 1952	17,854	12,431	10,701

over the period from 1951 to 1952. For example, the rate of increase in the sum of loans far exceeds the rate of increase in the sum of deposits in Nisattai-mura, and in Shibahira-mura, the sum of deposits is reduced to half. In Hanawakawa-

mura, the co-operative association, disregarding the sum of deposits, gave out loans to the extent of 10,000,000 yen which was double the sum of deposits, of which about 7,000,000 yen was the borrowed funds from other financial association, and the remaining 3,000,000 yen is debts unpaid. These debsts unpaid were caused by the men responsible for the operation of the oassociation during confusions at the time of the creation of the association, which remain unpaid to the date. The partners of the association have lost confidence in them, and tody, they draw out even the sum of money for the rice supplied to the Government or the very day it is paid in order to deposit it in a local bank. This is true in Shibahira-mura, and though it is one of leading apple-raising area, there is no relation financially between the raising of apples and the co-operative association.

Situations simular to those in Hanawakawa-mura were found to exist with regard to the sum of money for the rice supplied to the Government. In Nisattai-mura much cannot be expected of its co-operative association from the beginning, because of its backwardness in the structure of agricultural reproduction.

Next, there seems to be some defects in the method of making loans by the co-operative association. Loans are made in each village on the basis of the number of shares of capital funds supplied or on the ability to pay the debts such loans given beforehand for the supply of rice to the Government. Such being the case, the lower class farmers cannot make use of such loans, though the upper class farmers make it a privilege to utilize them. This can be seen from Table 52 which gives the deposits and loans of the whole farmers involved in the transfer of land according to their class.

Table 52. Amount of savings and loans of farms concerned with transfers (in thousand yen)

Class	Year / Item	4.1. 1951		9.1. 1952		4.3. 1953	
		Gained	Gave up	Gained	Gave up	Gained	Gave up
A	Savings	10.0	6.9	5.6	5.6	6.7	19.2
	Loans	13.6	1.9	13.0	4.9	10.0	5.9
B	Savings	3.3	5.7	3.9	8.7	1.0	13.4
	Loans	1.2	8.0	8.0	4.2	13.4	10.1
C	Savings	10.4	8.0	16.3	8.4	42.7	46.7
	Loans	2.2	4.8	17.6	18.1	9.5	15.1

It seems that the term of such loans is too short. For example, the sum of loans advanced by the co-operative association in Natsuta-mura, which is said to be the most excellent association in Iwate Prefecture, amounted to 13,572,000 yen for the year 1951, of which only 11,605,000 yen was advanced on agricultural bills, the payments to be made in 9 months or in 2 or 3 months. Therefore, it is not easy to make payment on the funds borrowed for the purchase of agricultural

lands in such periods of time as these. It might be added here that about 10 % of the whole farm houses utilized such loans, the sum per house being less than 35,000 yen. Therefore, it was impossible for farmers to count on their co-operative association for positive loans in purchasing agricultural lands, and the co-operative association have been doing what they can to prevent negatively farmers from falling to lower class by giving out small sum of loans as running expense.

(ii) Instantaneous contract.

It was found that the two villages in Akita Prefecture did not make use of the instantaneous contract with the Government as a means of finance, while the two in Iwate Prefecture utilized it. However, the advance of loans seems to have been made at the will of men responsible. As seen from Table 54, such loans were advanced to only one house in A class which was most urgently in need of them, and to a large number of houses in C class which was relatively in less need of them.

Table 53. Amount of funds borrowed from Government by instantaneous contract.

Village / Class	Nisattai-mura	Natsuta-mura
A	(1) 15,335 yen	— — yen
B	(5) 15,858	(3) 4,861
C	(4) 21,717	(5) 8,831
Per farm	(10) 18,373	(8) 7,347
Per tan (paddy field)	2,161	3,339

Note : i) ( ) = number of cases
ii) all the owner-farms.
iii) see p. 126

Table 54 shows the purposes for which such loans were used. The largest in number is the case where the primary object is to avoid the payment of inheritance tax to be imposed in the future by changing the name of the title holder within the family, being 7 in two villages all in the upper class. 4 hauses spent loans in building or repairing houses, 3 houses in payment of the price charged for the transfer of land, 2 in payment of living and medical expense and 1 in payment of expenses incurred in connection with the land improvement and purchase of

Table 54. Cases of instantaneous contract classfied by using the funds.

Purposes for using	Nisattai-mura	Natsuta-mura	Total
Avoiding the inheritance tax	2	5	7
House repairing expendeture	4	—	4
Charging for purchase land	1	2	3
Living and medical expendeture	2	—	2
Land improvement expendeture	1	—	1
Payment for Fertilizer	—	1	1
Total	10	8	18

fertilizer. Of all these houses, the ones which were really in need of such loans were the two houses which spent them in payment of living and medical expenses; they are all poor farmers. Loans are given according to the order in the social class, so the sum alloted to poor farmers is smaller than that alloted to other classes (refer to Table 55). By looking into the class of farm houses to which loans were advanced and the use to which they were put, we find that the number of houses given loans is the largest among the upper class, which was not in a position to give up their lands even if loans were not advanced. They spend loans mostly in the improvement of lands. However, the case is somewhat different with poor farmers. The loans advanced on the purchase of agricultural land being less than 10 % of the price charged for the transfer, it is questionable to what extent they are useful to poor farmers in preventing the transfer of lands.

Table 55. Case of loans classfied by rate of interest and farm size.

Class	No rate	Less then 5.5%	5.5–10%	10–13%	More than 13%	Total
A	3	1	2	3	—	9
B	6	3	1	—	1	11
C	1	—	—	1	2	4
Total	10	4	3	4	3	24

In the present survey, to the question "Would you sell your land even if loans with a low rate of interest were advanced?" asked of the parties to the contract, they unanimously answered, "Yes." The reason for this is to be found in the fact that this system of financing is so complicated in procedure that it will not be of any use in urgency and that the sum advanced is so small that it cannot cover the cost of purchase even if the whole lands be put in mortgage.

3) Rate of interest on loans.

In many cases, they borrow funds from their friends without any interest, the tendency being especially remarkable in Hanawakawa-mura and Nisattai-mura. Although 3 cases were found where funds were borrowed from friends with interest at the rate of more than 13 %, they are the cases similar to those of borrowing money from money lenders, the only difference being that the persons lending money are their friends, not the professional money lender.

As seen from Table 55 which gives the number of loans made to different classes, relatively low rate of interest prevails in B class, while in C class loans are advanced at a high rate of interest.

As to the securities given for such loans it was found that loans were advanced without any securities in 12 cases out of the total number of 24. This is probably due to the fact the greater number of loans are from their friends. No instance was found where they mortgaged their lands for such loans, and it is probably due to the fact that no loans were advanced by banks or by individual financier.

So far we have described how the positive purchase of land is fianced at present, but the establishment of a more rational financing system is desirable if we are to prevent the sale of agricultural land negatively and defensively and to maintain owner-fram system.

IX. Inheritance of Land

1) General circumstances pertaining to inheritance of land.

Table 56 gives the results of our survey on so-called "posthumaus inheritance of land caused by the death of the title holder. The occurrence of such inheritance differs in number with villages, the average being around 1.5% of the total number of farm houses. Even in Shibahira-mura where the case is largest in number, it was only 2.2%.

Table 56. Case of inheritance classfied by amount of properties inherited.

Villag	Case of inheritance in 1951	Per farm house	Less than 15 (in ten thousand yen)	15–30	More than 30	Uncertain
Hanawakawa	10	805,713 yen	4	3	3	—
Shibahira	17	323,892	1	1	4	11
Nisattai	12	256,687	7	2	3	—
Natsuta	8	844,279	2	1	5	—
Total	47	(Av.) 305,138	14	7	15	11

Table 57. Case of inheritance classfied by amount of taxation and form of inheritance.

Class	Amount of taxation per case	No taxed cases	Less than 10 (in ten thousand yen)	10–20	Single inheritance	Co-operative inheritance
A	— yen	13	—	—	13	—
B	46,010	20	9	1	27	3
C	59,950	3	1	—	4	—
Total	(Av.) 47.278	36	10	1	44	3

The sum of property inherited in each village was, on the average, was about 300,000 yen. But there seems to be a great margin in the sum between individual farm houses, which must be larger than what we think it to be. For this resaon, it is quite natural that this margin is varied even among the farm houses in the same class in the same village. This is due to the following circumstances. The assessment of taxes on the property inherited differs with tax office in charge, and there were many among farmers who tried whatever they could to have their property underestimated in order to avoid the payment of inheritance tax. In addition to these, there were some flaws in the method of survey of tax office and village office in surveying the farm house which was liable

to the imposition of inheritance tax and the one not liable to such tax.

Such circumstances as these have influence also on the amount of the inheritance tax to be borne by the farmer. There were 11 farm houses which had to pay an inheritance tax of about 50,000 yen per house (about one-fourth of the total number of houses paid inheritance tax), of which only 1 house belongs to C class, the other 10 houses in B class (refer to Table 57). There were differences in the amount of inheritance tax even among those in B class.

Table 58. Case of inheritance classfied by its farm.

Villag	Case of Total (1951)	Inheritance of farm properties	Single inheritance	Co-operative inheritance	Free gift
Hanawakawa	10	10	10	—	3
Sihbahira	17	17	17	—	11
Nisattai	12	12	11	1	3
Natsuta	8	8	6	2	18
Total	47	47	44	3	35

As to the farm of inheritance it may be said that it is in the farm of solar inheritance, and no instance was found of joint or installment inheritance. In inheriting property, the greater share is given to the legal successor, the first-born son, in every class in each village 5 cases were found where the first-born daughter inherited the property, but this was done not according to any particular custom, but merely because there was no male successor in the family.

2) Effects of inheritance on farm management.

This problem should be considered from two phases. First, it is necessary to consider whether the inheritance is so effected as to divide agricultural lands into smaller lots. Second, it is necessary to consider the effect of the expenditure incurred in connection with the inheritance on the running funds of the farm house.

Let ua take up the first point somewhat in detail, although it was been dealt with in previous sections. As seen from Table 58, there are (a) 44 cases out of the total number of 47 where the farming business is carried on entirely unchanged by a solar successor, and (b) 3 cases where the farming is carried on in a joint operation by the joint successors. In the latter case, however, it must be noted that the joint inheritance was adopted for the purpose of reducing the inheritance tex as much as possible, and that the farms were not under a joint management. Of course, there was no instance of divided inheritance.

No grave situation was observed such as dividing agricultural lands further into smaller lots through the death of the holder of the property.

There is another form of inheritance which, though not directly related to the posthumaus inheritance, has something to do with the dividing agricultural lands into smaller lots. Free gifts shown in Table 58 fall under this. Of such

Table 59. Advance loans at the time of inheritance.

Village	Case of advance loans of inheritance			Necessicity of loans		Case of loans classfield by purpose of use in case of "Yes"				
	None	Receive		None	Yes	Funeral expenditure	Clearing of old debts	Inheritance tax	Others	Total
		Case	Yen (per case)							
Hanawakawa	5	5	70,000	4	6	4	2	1	—	7
Shibahira	13	4	35,750	6	11	5	5	5	1	16
Nisattai	10	2	62,750	8	4	3	1	3	—	7
Natsuta	2	6	28,500	2	6	4	1	1	1	6
Total	30	17	43,063	20	27	15	9	10	2	36
Percentage	63.8	36.2	.....	42.6	57.4	41.7	25.0	27.8	5.5	100.0

free gift, the greater number is that which is given to a new branch family, as has been explained previously ; such an inheritance has always reduced the land of the main family in acreage. This newly created branch family cannot make a living only on the land given as a free gift, so eventually it has to lease other famers' lands on tenancy or to purchase some owner-farms, each of which gives rise to the transfer of agricultural lands, as seen in a number of instances in the present study. This is a problem which cannot be overlooked, because it is quite different in nature from the inheritance where the name of the tilte holder changes within a family or where the transfer is effected between such families.

A large number of free gifts was found in Shibahira-mura and Natsuta-mura where the sale and purchase of agricultural lands was less in number. In Natsuta-mura, in particular, the number of such free gifts is far greater than that of posthumaus inheritance.

Table 59 shows the results obtained from a survey on the second point, namely, the effect of expenses incurred in connection with the inheritance on the running expense of the farm. Of the total of 47 cases of inheritance in the four villages, 17 (about 36 %) were those where the inheriting family, being unable to keep expenses within their own means, borrowed funds from others, the amount being 43,000 yen per house. In Natsuta-mura, about two-thirds of the inheriting families borrowed money from others. For these reasons, we cannot overlook the effect of expenses incurred in connection with the inheritance.

Therefore, to the question "Do you think it is necessary to advance loans at the time of inheritance ?" 27 (about 60%) answered *yes*. In looking into the uses to which such loans were put, it was found that 15 (41.7%) spent it on funerals, from which fact it can be seen how strong the custom of making formal occasions most important is in the Tohoku Region. 10 (27.8%) used it in the payment of the inheritance tax. It is quite a burden for the farmer who has no reserve economically to pay the high rate of inheritance tax, and it is not rare that he is often forced to sell his land to pay it. For example, there were 5 such

cases in Nisattai-mura. 9 (25%) spent it in clearing off the old debt, such as medical expenses, etc. This is also a problem we cannot make light of.

From a study on the farms of inheritance, such as divided or solar, it may be said that there is no tendency apparent in each farm for further dividing agricultural land into smaller lots, except the free gift to a branch family in which such a tendency has become more forcible.

Again, the expense incured in connection with the inheritance, being consumptive in nature, sucks the running funds, making, in an extreme case, a farmer sell his land. Such an incidental expense often becomes a factor inducing the transfer of land, and this is the very reason why the advance of funds is so keenly desired at the time of inheritance.

Farmer and Agricultural Land*

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(Received March1, 1954)

I. Why a problem

Of all the reforms and changes carried out after the recent War in Japan's agrlulture, the land reform doubtlessly was of greatest significance. Nevertheless, desire of farmers for land, which must have been the most basic condition to be fulfilled, has still been left far from being satisfied. Therefore, the slogan "Give land to working farmers!" should be one of the primary tasks to strive for, or the primary goal, of the farmers' movement still today when the land reform has been apparently completed. A good evidence for it is a huge mass of small part-time farmers still existing in our agriculture. The average farm is even smaller in size now than it was before and during the War. Thus, an overwhelming majority of the farmers of this country are small farmers (though tenant farmers have sharply decreased while owner-farmers have come to take a majority after the War) and part-time farmers, and poor farmers, all at the same time. They were once tenant farmers, and the actual significance of the word "tenant farmer" has not been lost yet. These small farmers may be called self-sufficient farmers from the viewopint of the type of farm production. The terms "small," "part-time," "poor tenant," and "self-sufficient farmers" are different ways of calling the same group of farmers, each designating one of their different characteristics resulting from the same cause : smallenss of size of farm.

Then, we must ask why our farms are so small in size. This is important, among other purposes, I believe, in order to eliminate mistaken application of the Malthusian population theory, once the basic theory for farmers' emigration and still now being accepted commonly by the unthinking despite its apparent mistakes involved, which claims that shortage of farm land results from a too big farm population, that is, smallness of farm is an outcome of overpopulation.

The problem of the size of farm has been the subject of discussion once as the "large vs. small farm" argument, as the optimum farm size problem during the

* The 109th report of the Institute for Agricultural Research, Tohoku University (1953)

War, and as the problem of middle farmer in the post-war agriculture, with different colors at different times. At any rate, however, the samllness of size of our farms can not be discussed without reference to the land system and capitalism of this country on one hand and also the productive power on the other (It is a question in what concrete form the productivity presents itself in this country.), all as related to our subject. It is my intention here to make clear such points as why we have a huge mass of small farms, how they have come out, how it is possible to give our farmers the land they desire to have. It would be reasonable to consider as the starting point why the farmers want land.

II. Why they want land

It goes without saying how important a role the land plays in agricultural production. The land as a means of production is the object and, at the same time, means of labor. But this understanding alone brings no concrete information, for the land the farmers actually want is not a land in an abstract sense but a land in a real form to work on.

The land in a real form is not available indefinitely. Should it be, no piece of it would be owner-free. The agricultural land for a farmer is not a place of farming for hobby but a land on which to maintain the living of himself and his family by cultivating it, and to obtain a surplus if possible. A good evidence is the fact that the small farmers are generally part-time farmers. Such small farmers can not maintain their living through agricultural production alone and are making up for the deficit by an income from their off-farm labor. And they depend upon family labor for farming and, consequently, the agricultural income is actually equivalent, so to speak, to wages for the family labor. Thus, the farm production in this country can be classified into two types in reference to the size of farm.

Self-sufficiency production { Marketing production { Agricultural commodities ..... A (full-time) / Labor itself (off-farm) ..... B (part-time) }

A represents the case of a full-time farmer with a relatively large farm, and B a part-time farmer with a small farm. The full-time farmer can utilize all the family labor in agricultural production on his farm. Here, the products are consumed partly on his own farm, the remaining being sold as agricultural commodities. The receipts from sale of those products are appropriated to purchase of materials necessary for farm production, such as fertilizer, farming tools, etc., and materials for living like daily necessities. In the case of B, a small part-time farmer, small size of farm prevents full use of farmily labor on his farm. Almost all of the farm products are consumed on farm, some extra even

being bought from outside. Consequently, it becomes inevitable to sell labor itself in order to purchase materials necessary for living as well as farm production. This is what we call off-farm labor, and this is the way a part-time farmer comes out.

As long as the farmers of this country are placed under the conditions mentioned above, earnest desire of small farmers for land is perfectly understandable. Even for middle farmers, it is a matter of nature to want extra land in the event of change in economic condition, increase of family members, or something like that.

The desire of farmers for land, however, is not simply a one for more land in quantity, or in area. It is also a desire for a better land, that is, a land which is less distant from the farm-house, and which can bring a bigger crop with application of the same amount of labor and fertilizer. Why is it so ? It is because the current price of rice, for example, is not determined on the basis of the productive price on the worst land. The worse a land is in natural conditions, the more it is subject to damages by natural disasters. Moreover, as a matter of fact, the small farmers, who were or still are tenant farmers, have been compelled to cultivate such lands as are more subject to damages by flood, drought, etc., more poorly drained or equipped for irrigation, or located more scattered and distant from their farm-houses.

As is apparent from the foregoing discussions, many farmers desire land not for making profit on it, but rather only for maintaining their living. And the land they desire to have is a one not only larger in area but also higher in productivity.

Then, the question arises : how can they obtain such land ? Before answering this question, it must be made clear what really prevents this desire of farmers from being realized at the present time. For this purpose, it would be reasonable to have a look at the present situation of size of our farms as observed from some actual data.

III. Variation in size of farm

It is well known that the area of agricultural land per farm in Japan is smaller than that in any of foreign countries, except for some Asian countries. But comparison of the area of land per farm can not be very useful in itself because the difference in size of farm does not necessarliy mean a difference in the scale of farm production activities. Furthermore, the average figure for a community, village, county, or prefecture is not always directly indicative of actual situation. Even if the average size is small, there may be some large farms included as components. Therefore, the process of averaging cancels out the social structure of the community or village concerned. Also, comparison of size of farm is meaningless between different types of farm managements. The size of farm

itself does not necessarily indicate social relations.

In Japan, however, the problem lies in the fact that the size of farm indicates relations of production.

As mentioned previously, it is observed as a common phenomenon in every section of the country that tenant farmers are small farmers. And large farmers are generally landlord-farmers or owner-farmers : landowners in any case. This means that the difference in the size of farm directly indicates the difference in social class and social character of the farmers concerned. This point must be scrutinized more closely. Please look at the table below.

Farms of Different Sizes as Percentage of Total.

Size of Farm in *tan* / Towns & Villages	0–3	3–5	5–10	10–15	15–20	20–30	30–50	Type
Nakaniida-machi, Miyagi-ken	18.7	22.0	33.7	14.6	5.4	3.8	0.3	A
Nango-mura, Miyagi-ken	5.6	7.7	16.3	13.7	16.5	29.0	11.0	B
Okitsu-machi, Shizuoka-ken	37.3	21.8	27.3	8.9	3.2	1.4	0.1	C

Source : For the villages of Miyagi Prefecture, Handbook of Cities, Towns, & Villages of Miyagi Prefecture.
For Okitsu-machi, Shizuoka Prefecture, Tokuzo Matoba, Economic Studies on Orange Production in Japan.

The three types fo farming areas, designated by A, B, and C in the table (though those towns and village were chosen at random) are the basic models as indicated by different sizes of farm prevalent in the areas concerned. In Type A area, most of the farms are ones of 5 to 10 *tan* while a small number of large farms are included, too. This pyramid is to be observed in the rice areas, where agricultural production is generally lagging behind and tenant and part-time farmers are largest in number, and other farming areas, but most often in the class composition of farms in forest and fishing villages. These facts quite naturally make us believe that this type of area is basic for and representative of Japan's agriculture. Type B area is characterised by that it has the largest number of farms of 10 *tan* or more. The central part of the rice area belongs to this type. This type has the largest average size of farm and the largest number of full-time farmers. Type C area also comprises largely farms of 5 to 10 *tan*, and almost all farms in this type of area are those of 10 *tan* or less. Few large farms are included. This type is most often identified in the orange or apple areas, vegetable areas near cities, and dairy areas, where marketing production has progressed. A larger part of the farmers of this type of area are full-time farmers in spite of small size of farm.

What will give rise to such variation in the type of farm, then ? Of course,

the basic reasons do not lie in the natural or technical conditions such as one is rice area while another is fruits or dairy area, and the other is forest or fishing village. This can be seen from the fact that what prevents farmers from obtaining more land has nothing to do with the difference in the type of land use, that is, paddy field or upland field. We also have seen previously that this is neither due to too little agricultural land and too much labor.

IV. Land system and size of farm

The three model types of farming area described above are observed in practical conditions more or less in the forms of intermediate or mixture of two or more of them. In any case, the question is how these different types have developed. Here we must take into consideration the relationship between development of these different types of areas and the land system in this country. A primary reason for it will be understood in reference to the socio-economic character of the landlord. Although we do not have enough space to examine statistical figures, the following will deserve mentioning.

The Type A area is most often identified in an area where there are residential landlords farming himself, too, of forest landlords ; Type B in an area where absentee land-lords or non-farming landlords are large in number : and Type C most commonly in villages where owner-farmers constitute a majority. In this last area with the largest percentage of owner-farmers, peroductivity is usually high — most commonly observed in areas of advanced marketing production, such as commercial farm area producing oranges or any other fruits. The suburban areas with small farms should be considered as Type E. Marketing production in our agriculture has developed with increase of owner-farmers, that is, it was developed by reclamation of forest lands, native grasslands, and other waste lands into upland fields, etc. In any case, Type D (or E) area took its shape through commercialization of agricultural products on one hand and of labor on the other in the developing capitalism. The above is one reason, and we must mention the other for perfection. It will become clear if we know how farmers have acquired ownership or lease or use right of the agricultural land.

As for the ownership in the first place, the resport of the survey conducted by the Ministry of Agriculture and Forestry on the relationship between both parties of land transaction during the year of 1939 stated as follows : "In examining the relationships between those who sold and those who bought land, it should be noticed that nearly half of all the cases in 1993 were purchases by tenants from their landlords. And it is also noticeable that the price paid for the land in such transactions was generally lower than in other cases." (Yasuo Kondo, "Outline of Results of Case Survey on Transaction of Land," Norin-jiho, March issue, 1941) It will be a question here why the price is lower in the transfer of land from landlords to tenant farmers. Another survey of similar nature reveals that

the price was paid in cash only in few cases of such transfer of ownership of the agricultural land, and an overwhelmingly majority of the cases were transfer of land acompanying the creation of a branch family, or for other reasons of kinship, or for some reasons related to employment, including the servantmaster and landlord-tenant relationship.

Also for acquisition of lease, the cases related to kinship or accompanied with the condition of offer of labor (chiefly in the case of making the farm-servant a tenant) on the part of the tenant.

As will be seen from the above, the ownership or lease of land has, in most cases, not been acquired through ordinary transaction with money. (Concentration of land in the hands of landlords was made through purchase with money, but it was actually an acquisition by usurer or commercial capital not a transaction in a modern sense.) This is supported by the fact mentioned previously that the small tenant farmers are cultivating lands not only smaller in area but also lower in productivity. Therefore, it can be said that the land which our farmer are cultivating is eassentially of the nature of feudalistic grant in the point that it has been acquired through kinship (which is based, in turn, on ownership of land) or employment relations (which is determined by ownership of land). In those areas, therefore, where many landlord-farmers, who need to maintain sufficient labor (which should be cheap, too) around their own farms, exist, development of a mass of small farms around the landlord-farmer as the top of the pyramid is inevitable. The landlord-farmer is their landlord and, at the same time, their head house. This is how the farming society of Type A develops. In the case of Type B, as the landlord is an absentee one or, if resident, a one that owns a very large area of land, he can depend for his living solely upon land rent income, not necessarliy upon his own agricultural production. He, therefore, rather rarely needs cooperating small farms around his own farm, or none if he is an absentee landlord. With such type of landlord, tenant farmers can have relatively large area of land to cultivate, and for the landlord himself, too, it may be safer from the viewpoint of security of land rent to have large tenant farms.

Type C can be regarded as an exception which grew out of Type A or B (Of course, however, the principle of Type A persists more or less still now in the Type C area.), for it managed to develop, getting rid of the pressure of the landlord system in one way or another, as mentioned previously. What made it possible was high productivity obtained through marketing production. This type may be said to have come into existence by breaking the fetters of the landlord system, and may also be said, as far as this fact is concerned, to have developed under the influence of the capitalistic economy.

Generally speaking from the above evidences, the agricultural lands have been transferred from particular persons to particular persons. This corresponds to the fact that the agricultural land here is not simply a means of production in

pursue of profit, as is the case in the capitalistic farm management.

Under the land system described above, the land rent naturally had to be high and also to be a products rent. Why ? As far as the high rate of the rent is concerned, the reason lies in the facts that the tenant farmers did not farm actually for a certain level of profit, and also that his farming was done under the control of his landlord. The pressure of overpopulation because of the capitalism constituted a supporting factor for the above conditions. The reverse can not be true, however ! Thus, this high rate of land rent exploited any accumulation of fund on farm, prerequisite for an expanding reproduction in the farm management.

Also, the products rent (on a fixed ratio basis in most cases actually rather than on a fixed amount basis because the "reduction" was a common practice) deprived the farmer, actual producer, of his competence as marketing producer. This means that it prevented contact between the capital and the producer. Moreover, the fact that the land rent was actually on a fixed ratio basis implies security of control by the landlord. Payment in products and the fixed ratio can not be considered separately because the fixed ratio naturally requires payment in products. Thus, smallness of tenant fram and high rate products rent are combined in the phenomena. And, as discussed previously, to keep tenant farms small was a means of securing enough labor for the own farm of the landlord. It can be said, therefore, that the most essential character of our land ownership system is to be found in the samllness of farm size. The problem of land rent centers around the phenomena resulting from such system of land ownership. It would be necessary, however, to point out that the capitalism also is creating small farms in suburban areas on the other hand.

V. Capitalism and size of farm

Progress of marketing production, needless to say, reduces control of the landlord system. Then, in what ways the land ownership system of this country has restricted development of marketing production may be questioned. Summarizing our previous discussions, we can point out in the first place that it has kept the size of farm so small that production for own consumption was more important. Secondly, the high rate of land rent and, thirdly, products rent were other factors. And lastly, furthermore, the landlord system prevented, on the other hand, normal progress of commercialization of farm labor by binding it on the small farms.

Consequently, the increase of agricultural products of the nation as commodities has been brought about not by expanding production on each farm but only by increase of farms in number. And the production of commercial crops like various fruits had to manage to get rid of the pressure of the landlord system for development. Then, on the other hand, how has the capitalism of this country

influenced marketing production in agriculture ?

Needless to say, the capitalism functions to break down the old self-sufficiency production relations and accelerate progress of marketing production, that is, it diverts products, for consumption on own farm formerly, to market by involving the farm in the commercial economy. The "emergency sale", as they call it, of the rice originally kept for own consumption by small farmers will provide a good example. However, the capitalism of this country, which reached its monopolistic stage in relatively early days of its development, can not necessarily be thought to have had an encouraging effect on marketing production in agriculture. This will be seen from the fact mentioned above that increase of the agricultural products for market was made possible in this country not through expansion of production on each farm but through expansion of total number of farms, that is to say that it was not a result of expansion of marketing production on each farm but was brought about without qualitative development of the individual farm management. It is too obvious that this does not mean any qualitative progress of Japan's agriculture as a whole.

Such situation as we have observed in the above discussions give rise to the fact that marketing production is possible only when basically supported by self-sufficiency production. It will be exemplified by the farm-made manure on a rice farm and home-grown fodder on a dairy farm, but much better by the fact that the farm can not exist without family labor. Such situation naturally requires production of food for own consumption. This, when viewed in relation to the capitalism, results from the samllness of domestic market, or, more concretely, the fact that the general prices of agricultural products are determined at such a low level that the productive price of them can not be realized. Consequently, those farms which depend entirely upon commercial fertilizer and feed, and hired labor can not exist.

If a farm management can exist only on the basis of family labor, the size of farm will have to be limited by the quantity of family labor available. Here, we find an effect of the capitalism toward maintenance of the small size of farm. The capitalism has also been creating daylaborer-farmers around cities, as mentioned previously. And also, the need for production for ownconsumption as a natural result of use of family labor on farm prevents perfect commercialization of labor. Thus, as far as production of food and other neacessary things for own consumption is indispensable to a farm, a certain area of land will always be taken up by such production, leading to a higher dependence on the land. Japan's capitalism requitres cheap agricultural products, and indispensably needs cheap labor, too. It will be clear from the above discussions that the small farms provide the base for supply of them. Here, we see an agreement of interest between the capitalism and the land system with landlords as a controlling power.

VI. The land reform and size of farm

What change did the recent land reform bring about in the size of our farms ? Generally, the answer should be "no change", of course. In the land reform, a larger part of the leased lands were transferred to the tenants who had actually cultivated them, and the absentee landlords nearly totally disappeared as far as the arable land is concerned though forest landlords has still been kept intact. It is an established fact, however, that very little decrease occurred to the number of landlord-farmers. This means, when viewed from another side, that about as many small farms still exist as before, which is the very situation that is observed as a common phenomenon and problem in the rural society all over the country. Consequently, the desire of the farmers for more and better lands has been left still unsatisfied. This is because the lands were simply given to those who were cultivating them in the land reform. It could be done without affecting the ground of the landlord-framers who held an important place in our landlord system. It was done by giving leased lands to their actual cultivators. Then, the effects created by elimination of high rate products rent as a result of the above action, or change from products rent to money rent may be questioned. Elimination of products rent did accelerate marketing production on farm, and thereby get farmers in closer contact with the capitalistic economy outside. For this very reason, on the other hand, the farmers had to face themselves a large sum of imposition of taxes and the like in place of the land rent before, and also the squeeze between the prices he paid and received. As a result, the situation still did not improve for them because no fund for expansion of farm production was left in their hands, just like prior to the reform ! The only difference was that a monopolistic capitals came up before them just in place of the absentee large landlords before the reform. It is still true in any case that the capitailism works to maintain smallness of farm size. It can be said therefore that the capitalism and the landlord system of this country still stand side by side on a common ground.

Since the essential part of our landlord system has been left unaltered, as discussed above, and also the capitalism exists in a more aggravated form, one can not even imagine that the desire of farmers for land would be satisfied in the near future. Indeed, it may not be absolutely impossible to obtain more materials to improve their living standard and also to expand farm management economy on a certain given area of land through higher rate of marketing production. Development of dairy farming after the War will present a good example for it. Even in the case of such commercial farming, however, there still exists a limiting factor, aside from the size of farm, of primary reliance on the family labor and, consequently, importance of production for consumption on own farm. And it seems, moreover, that this limiting factor tends to be even strengthened. It will be indicated by the recent declining trend of the prices for agricultural com-

modities, such as for fruits and milk, for example. This shows that there exists a maximum limit for development of marketing production. In fact, it is a very small number of selected farmers who successfully expand marketing production, or who are able to do it beyond the above limit. It should be noted also that those selected farmers belong to the upper half of the middle calss or higher classes, which were ruling classes of the rural society even prior to the land reform, that is to say that they were no small farmers at all.

Summary

The land reform carried out in post-war Japan failed fully to satisfy the farmers' desire for land.

The farmers of this country want land not for making profit through farming on it, but rather merely for maintaining their living. And they want a land not only larger in area but also higher in fertility.

The farming areas of Japan may be classified into three types by the size of farm prevalent in each area :

Type A – – The area where a large number of small farms exist around a few large ones – – forest villages, fishing villages, etc.

Type B – – The area where a majority consists of full-time farmers with farms of a relatively large size. – – areas raising rice as the only crop.

Type C – – The area where a large number of small farms prevail – – fruits areas, vegetable areas, etc.

Development of these different types has been related to the land system of this country. Land has been obtained by farmers through the lease or transaction in a modern sense in few cases, and through such casues as granting of land to the farm-servant or creation of a branch family in most cases, except for in Type C area.

The land reform gave the farmers ownership of farm land, but no change has been effected to the size of farm or conditions of the farm land. Morevoer, the former land rent of high rate was replaced only by a larger sum of taxes and other public impositions.

To satisfy the desire of farmers for land, an overall reform of the land system and elimination of the pressure of the capitalism on the agriculture are needed.

東北大学研究所報告
(農　学)
第 5 巻

昭和 29 年 3 月 25 日 印刷
昭和 29 年 3 月 30 日 発行

編集者　寿時富弥
仙台市片平丁75 金属材料研究所内
東北大学研究所連合会

発行者　坂本正幸
東北大学農学研究所
仙台市片平丁 41 番地

印刷者　笹気幸助

印刷所　笹気出版印刷株式会社
仙台市堤通27 電話③ 2027, ③2207 番

Printed by
SASAKI PRINTING & PUBLISHING Co., Ltd.
27, Tsutsumi-dôri, Sendai, Japan.

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